1. EXECUTIVE SUMMARY

This pilot study tests a proposed National Forest and Grasslands Road Analysis Process. Both the proposed road analysis and this pilot project are ***NOT*** decision-making processes. Road analysis is intended to be an assessment tool that is part of a systematic approach to Access and Travel Management (ATM) planning and decision-making. The ultimate decision process for ATM will also consider other elements and information, such as:

- Key Watershed restoration strategies and
- Collaboration with Tribes, local watershed councils and other local, state and federal agencies.

This pilot analysis will be reviewed in concert with five other National Road Analysis pilot reports to determine the final process which will be applied in Fiscal Year 1999 to all National Forests and Grasslands.

1.1. Background

The objective of this analysis is to furnish information that will help us manage a forest transportation system that:

- Is environmentally sound,
- Provides safe access and meets the needs of communities and forest users,
- Can be maintained within our current and projected financial abilities, and
- Facilitates the implementation of the approved Forest Plan direction.

Each National Forest and National Grassland has a unique history of how "their" forest roads and transportation system were developed. Public and community involvement in this development provides a rich history in and of itself that reflects the national, regional and local emphasis through the eras of conservation and environmental thought and decisions. This report reflects the development of the transportation system on the Willamette National Forest (NF) during the decades of intensive timber management. It also describes the existing condition of the transportation system and how it relates to current management objectives, which are significantly different from those in previous decades.

1.2. Key Analysis Results and Findings

The following results and findings are based on analyses documented in the appendices of this document.

- Economics alone (financial efficiency) does not support large-scale road closures or decommissioning in spite of the current imbalance in funding available for road system management.
- Natural resource factors, rather than questions of administrative or public use, are the drivers that identify Forest level observations. Priority setting for road management action needs to be integrated at the appropriate scale (sixth field subwatershed or larger) with completed Northwest Forest Plan watershed analysis recommendations; political, community, public existing agreements; and future interests in issues. The key natural

resource factors to consider on the Willamette NF in defining the future transportation system are fish, wildlife, water quality, and other ecological values.

- Interdisciplinary teams will need to develop a list of key natural resource factors and landscape/ecological data that can be used to sort and rank potential hazards created by the transportation system. In turn, this ranking can be used to identify and define priorities for further action. This information should be integrated with the other factors mentioned previously at the appropriate watershed and community scale for decision-making.
- Previous decisions made by Forest managers, such as defining the primary and secondary road network, should be revisited due to current Forest Plan allocation direction. The existing transportation system may no longer be consistent with management objectives and administrative needs (*e.g.*, Late Successional Reserves [LSRs]).
- Only a few of the existing unroaded areas (approximately 20%) are in land allocations or parts of the Forest where additional road access is needed to implement Forest Plan direction.

We lack key data and baseline analysis necessary for integrating and prioritizing social and community aspects and interests in the national road analysis process. From our Central Cascades Adaptive Management Area and project Access and Travel Management planning and public participation experience, we know collaboration is important and takes quality time spent with people representing all the affected interests. Each interest is specific in its views of the road system and how it should be managed within a watershed and community context.

It is also difficult to retrieve all road management agreements and easements in order to have the complete data set needed for transportation system decision-making. We are not able to retrieve this important data in the pilot analysis timeframe. We have cost-share road agreements and memorandum of understandings with Federally recognized Indian Tribes, Federal, State and local road management agencies. These all need to be factored into the analysis, adding complexity to the analysis process and timelines.

1.3. Next Steps

The results documented in this pilot road analysis will be reviewed by the National Road Analysis Team during the next few months, and will be used to refine the final national road analysis process expected to be available early in 1999.

In the interim, the Willamette NF has several opportunities or options to prepare for further road analysis based on the critique of this pilot effort.

1. Initiate an internal review of the data, methods of analysis and results with the District Rangers and staff. The report identifies some known data problems. Other concerns may be identified through District review. As these are identified, the Forest should undertake action to ensure that critical Forest databases are updated in preparation for the final road analysis process.
2. Develop a Forest level, GIS database of existing road agreements, such as easements and cost-share roads.

3. Develop a Forest strategy and methods for effective public involvement and collaboration that can be applied to future road analyses or Access and Travel Management planning at different scales. Consider prioritizing areas on the Forest for different degrees of collaborative efforts.
4. The resource specialists on the road analysis team could document and "package" analytical methods and tools used and developed in this pilot process, so those tools can be easily transferred and applied to road analysis at the watershed or subwatershed level. They could also be used to update the Forest level analysis when the national process is released.

1.4.

2. INTRODUCTION

2.1. Overview of National Forest Road Analysis Proposal

Land allocations, management strategies and the road maintenance budget have changed significantly during the past decade. It has been determined that road analyses are needed on all National Forests and Grasslands to better coordinate our road management programs. The analysis process will provide land managers with a science-based analytical tool to help balance public needs, scientific information and funding levels when determining the size, purpose and extent of future forest road systems.

The Willamette was one of six National Forests selected to test the draft road analysis process developed by the national Forest Service Team. The primary objective of this pilot testing was to assure that the final road analysis process can be implemented efficiently and effectively nationwide. Once pilot tests are completed on October 31, 1998, the draft process will be revised to address lessons learned during the testing phase. It will be subjected to a scientific peer review in early 1999 and suggestions for improvement in the process will be incorporated.

Road analysis is ***NOT*** a decision-making process. Rather it is designed to provide an assessment of the existing forest road system from a landscape perspective. It highlights problem areas and opportunities in the road system, so Forest Service land managers can make better management decisions regarding the transportation system on national forest lands.

While the lack of sufficient maintenance funding is ongoing and serious, it is very important that issues are assessed not only from the economic perspective, but also from social and ecological perspectives. The objective is to provide a safe and environmentally sound transportation system that meets people's needs at a realistic and sustainable funding level.

2.2. Scope of this Analysis

A Forest-wide road analysis was completed, identifying pertinent ecological, social and economic issues and needs essential to making future decisions about the characteristics of the Forest transportation system. These issues and needs were used to identify road management opportunities that would improve characteristics of the Forest road system to balance the benefits of access with road-associated environmental effects, road management costs and social/community interests.

2.3. Purpose of the Pilot Road Analysis

This project was a pilot process, testing the efficiency of a process developed by a national Forest Service team. Its purpose was to not only perform the analysis but also provide recommendations to improve the analysis process. Pilot testing will assess whether the process is:

- Useful at the field level (at various landscape scales)
- Applicable across wide and diverse geographic areas and ecological conditions

- Usable by field units with diverse budges and expertise
- Usable by units with diverse natural resource management objectives
- Useful for analyzing both roaded and roadless lands
- Consistent with adaptive management by incorporating a feedback loop.

The process will be further modified based on the knowledge gained from field testing. Once the feedback from pilot tests is incorporated into the process, it will be ready for a rigorous scientific peer review.

3. Background and Context

3.1. Historical Context

The Willamette National Forest includes more than 6,300 miles of road. The road system has evolved over time, but the vast majority of roads were constructed from 1960 to 1990. The first roads built through the Willamette NF were routes across the Cascade mountains to move people and goods from east to west. These early roads followed existing trails used by indigenous groups for thousands of years. As transportation needs changed over time, the routes were reconstructed to higher standards. Trails were normally located along rivers and streams; consequently many of the main roads today are located in riparian zones.

In the early 1900s, road standards were developed calling for "truck trails" to be constructed nine feet wide. These roads were to exclude any excess width. The primary purpose for construction was to provide administrative access for fire protection. Although we don't have any records of these truck trails, they do not account for many of our road miles.

In the 1920s the Regions of the Forest Service were directed to undertake a transportation planning effort to determine the road system required for effective fire protection. Few roads were constructed during that era, but when the CCC was established, planned road projects were available for construction. Again, we have no records of roads built, but the number of miles was quite low.

In the late 1940s demand for timber products increased significantly. Congress began to appropriate large road budgets. Many of the mainline roads were designed and constructed by the Bureau of Public Roads, now the Federal Highway Administration. These roads were normally constructed to highway standards. The Forest Service was responsible for the construction of lower use project roads, such as the roads within a timber sale area. Often, the road location and standards were left to the timber purchaser's discretion. In the urgency to provide timber access, "many miles of primary timber access roads were hastily surveyed and constructed with insufficient attention to possible watershed damage and future requirements" (USDA, 1990c).

In the early 1950s the Forest Service began using strict geometric standards that set limits on grades and curves. Although designed to strict standards, construction practices often allowed slash to be buried within the roadway, a practice that would trigger future road failures as the slash decomposed. A Forest inventory from 1952 shows a total of 693 miles of road on the Willamette NF. Although many of these were main access roads, there is little comparison with the 6,300 miles currently in the inventory.

The vast majority of the roads on the Willamette NF were constructed from 1960 through 1990. During this period road standards and political interests varied significantly. From 1960 to 1976 strict geometric standards were used. When constructing these roads, excavations, often resulting in large road cuts and fills, were required to establish alignment and grade. After 1976 non-geometric design methods were used. With these methods, the road alignment and grade was adjusted to follow the existing contour of the ground as closely as possible, resulting in significantly less ground disturbance. Non-geometric methods are still currently in use.

In the late 1960s and early 1970s, road construction programs were quite large. To ensure that the Forest Service was receiving the quality of road paid for, an emphasis was placed on contract administration. A national training and certification program was developed to ensure that contract administrators were qualified and experienced.

The non-geometric design coupled with well-trained administrators significantly reduced problems associated with road instability. In the early 1980s, new road standards were implemented. These standards allowed the Forest to reduce ecological impacts by setting road standards based upon resource needs for roads. The standards allowed serviceability to be sacrificed in order to mitigate environmental impacts.

Reconstruction by timber purchasers was limited in the early 1980s due to the high cost of the road program. Although short lived, this limit on reconstruction significantly reduced the amount of mitigation funds for resurfacing roads. Loss of surfacing can lead to rutting, erosion, and ultimately sediment delivery to streams.

The Willamette has maintained a large reconstruction budget since the early 1970s. Through this program, many unstable areas associated with early road construction practices have been stabilized.

3.2. Roadless Areas – Historical Context

The issue of roadless areas gained prominence on the Willamette NF during the early 1950s, when forest management (timber harvest and road construction) began to intensify and the Chief of the Forest Service deleted a 53,000 acre area, known as French Pete, from the Three Sisters Primitive Area. Public concern about French Pete and other roadless areas within the Forest increased during the past 40 years. In addition, the issue of preserving roadless areas for their wilderness character and primitive recreation opportunities has expanded. It now includes concerns for providing adequate habitat to sustain viable populations of wildlife, fish, and plants; protecting sensitive soils and unstable lands to maintain water quality; and maintaining representative ecosystems of the region and nation. The Wilderness Act of 1964 resulted in a total of 254,744 acres of congressionally designated wilderness on the Willamette NF by 1968. These areas were mostly on the eastern edge of the Forest along the crest of the Cascade Mountains, many in the Primitive Areas.

Public interest and controversy surrounding roadless areas continued to grow in the 1970s, both on the Willamette (where French Pete continued to be a focal point) and at the national level. In 1971, a national review and evaluation of roadless areas on National Forests was initiated, commonly referred to as RARE I. Ten roadless areas on this Forest were identified in RARE I and over 5,000 comments were received just on the roadless areas of the Willamette. In 1973, the Chief of the Forest Service announced that 274 roadless areas nationwide would be studied for inclusion in the National Wilderness System, four of them on this Forest. None of the French Pete areas were included in these four. The final decision on RARE I was short-lived, however, as it was appealed by various environmental groups and the EIS (Environmental Impact Statement) was found to be inadequate. This resulted in a new review of the roadless areas, referred to as RARE II.

RARE II began in 1977 and, using new criteria, resulted in consideration of 624 roadless areas for wilderness inclusion nationwide, eleven on the Willamette. The French Pete

controversy was resolved in 1978 with the passage of the Endangered Wilderness Act. The RARE II EIS was also challenged and determined to be inadequate. As a result, in 1984, the Oregon Wilderness Act added a large series of wildernesses on the Willamette, including Waldo Lake Wilderness, additions to Mt Jefferson, Mt Washington, Three Sisters and Diamond Peak. It also created two new wildernesses on the west side of the Forest in the lower elevations: Menagerie and Middle Santiam. This was a change from the other wildernesses, which are geographically associated with the high peaks of the Cascades. The 1984 Act also created the Bull of the Woods Wilderness, which overlapped both the Willamette and Mt. Hood National Forests.

The next review or evaluation of roadless areas on the Forest occurred in the late 1980s during the development of the Forest Plan. Thirty-one roadless areas (172,007 acres) were evaluated. A detailed discussion of each area's attributes and resource potentials was developed as Appendix C to the Forest Plan FEIS (Final Environmental Impact Statement). In addition to the 31 roadless areas, the Forest also identified 24 other unroaded areas ranging in size from 1,500 acres to 4,500 acres. These areas were too small for inclusion in the roadless area inventory, but were considered large enough to provide semi-primitive dispersed recreation opportunities. In the 1990 Forest Plan, 25 of the roadless and unroaded areas (85,768 acres) were allocated to land allocations that maintained semi-primitive, nonmotorized recreation opportunities.

The most recent changes to the roadless and unroaded areas on the Willamette occurred with the Northwest Forest Plan (a.k.a. The President's Plan) in 1994, which amended the Willamette Forest Plan. Opal Creek Wilderness legislation in 1996 created the Opal Creek Wilderness and established a scenic recreation area overlapping several large parcels of roadless and unroaded areas in the Little North Santiam watershed and the Opal Creek subwatershed.

The following table (Table 1) tracks the acres of roadless and wilderness on the Willamette NF from 1964 to 1990.

Table 1. Roadless and Wilderness acres from 1964-1990.

Classification	1964	1968	1973	1979	1984	1990
Wilderness	191,063	254,744	254,744	301,933	386,863	386,863
Roadless	Unknown	Unknown	357,127	301,227	210,207	172,007
Total Undeveloped	Unknown	Unknown	611,871	603,160	597,070	558,870

4.

5.

6. CURRENT SITUATION

6.1. Road Statistics

6.1.1. Miles by Maintenance Level

There are 6,364 miles of Forest Development Roads (FDR) in the Willamette National Forest transportation inventory. Twenty five percent (25%) of the road system is in the Maintenance Level 3, 4, and 5 categories (maintained for standard passenger cars). Maintenance Level 2 (maintained for high clearance vehicles) accounts for 63% and 12% are roads currently closed to vehicular traffic (Maintenance Level 1) (*see Table 2 and Figure 1).*

Table 2. Miles of Forest Development Roads by Maintenance Level

Maintenance Level	Miles	Error (+ or -)
1. Closed Road	736	15%
2. Maintained for High Clearance Vehicles	4067	10%
3. Maintained for passenger car, low user comfort, aggregate surface	1191	5%
4. Maintained for passenger car, moderate user comfort	124	2%
5. High standard passenger car road, double lane paved	246	2%
Total	**6364**	

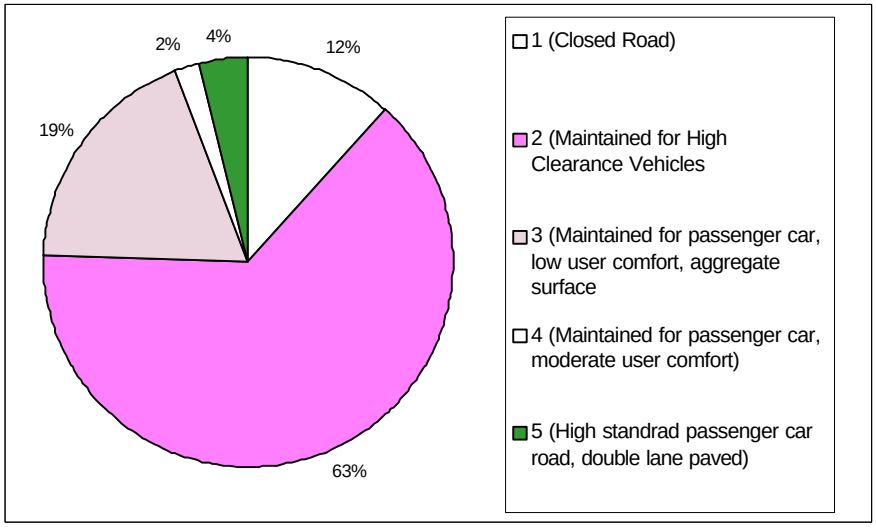


Figure 1. Miles of Road by Maintenance Level

6.1.2. Unclassified Roads

There are 360 miles of unclassified wheel tracks documented as GIS line segments on the TRAN Layer. It is thought that the actual miles of undocumented wheel tracks on the Forest are probably double that amount. In general, it is thought that unclassified roads have a low impact in terms of erosion and sedimentation. A recent road inventory of Coffeepot Head BGEA supports these assumptions *(see Economic Process Paper, Appendix A).*

Unclassified roads typically result from low-standard temporary roads built within the scope of timber sale contracts. Temporary roads are not recorded or mapped in the Forest database. After intended use, such roads are typically decommissioned but are often visible as primitive wheel tracks or show up as features in aerial photos. Unclassified roads also result from unauthorized off-road vehicle use to access dispersed recreation sites.

6.1.3. Data Accuracy

Numerous corrections and revisions have been made to the Transportation database (TMS) since 1992. However, mapping and database errors do exist. Table 2 gives an estimate of the current status of errors in transportation data (i.e. GIS map locations, mile totals, open or closed status, or road existence differing from actual field conditions). About 100 miles of road in the TMS do not have corresponding line segments on the GIS transportation map. Many of these roads are no longer apparent on the ground.

6.1.4. Key Forest Travel Routes

The primary/secondary road system was identified in a Forest-wide Access and Travel Management (ATM) analysis in 1995. These consist of 2,130 miles providing the key travel-routes needed for long-term management of the National Forest. They provide vital linkages to local communities, State and County Highways, private land ownership as well as furnishing inter-forest connections to trailheads and major recreation sites *(see Table 3).*

Table 3. Forest ATM Route Designation

ATM Designation	Miles
Primary (High standard through-routes, arterial linkages, Scenic Byways)	430
Secondary (Key inter-forest connections to interior recreation, forest management, fire response)	1,700
Local (Candidates for reduction of maintenance standards, decommissioning or obliteration)	4,234

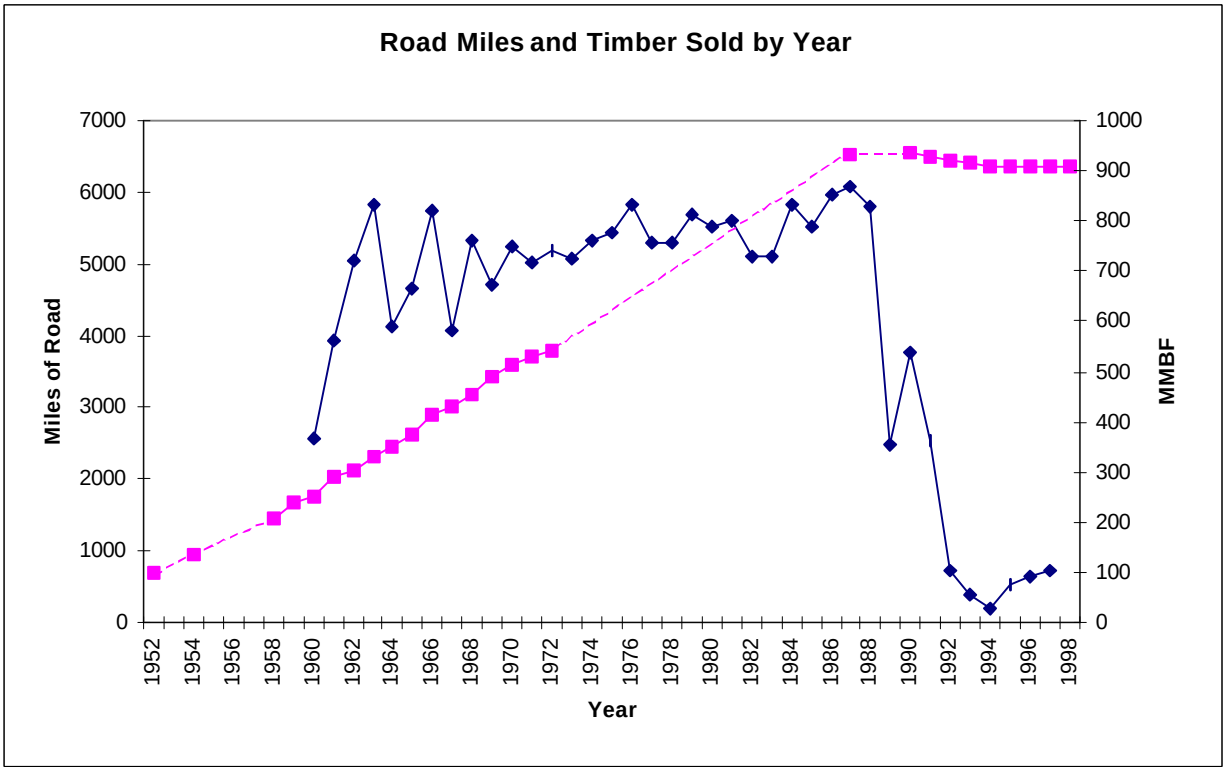
The remaining roads not designated as primary/secondary are generally local routes whose long-term status will be analyzed at the watershed or project scale. These routes are considered candidates for reduction of maintenance standards, decommissioning or obliteration.

6.2. Economic Situation

The range for direct road costs (such as maintenance, repair, closing, etc.) is large because actual costs are directly dependent on the unique characteristics of a particular road or road system, such as topography and soil type.

6.2.1. Background

Figure 2illustrates the road-building trend on the Willamette National Forest from 1953 to



1998. New road construction averaged in excess of 100 miles per year between 1953 and 1989. These roads were primarily constructed to support timber-related land management objectives prior to the 1990 Willamette Forest Plan as amended by the NW Forest Plan. Each mile of constructed road is dependent on annual maintenance to keep the road safe, environmental risks to an acceptable level, and to protect the road investment. These roads were constructed with the expectation that timber-based land allocations would generate funding for annual road maintenance on a long-term basis.

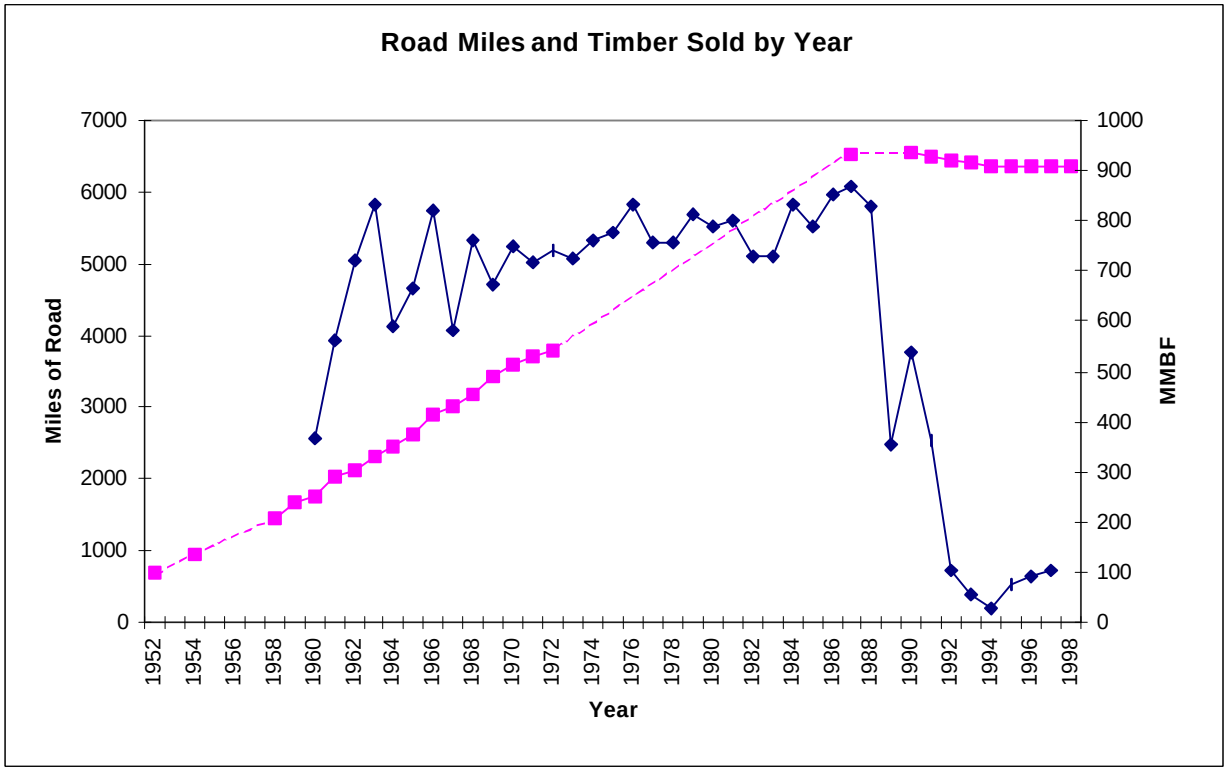


Figure 2. Miles of Forest Development Road from 1953 to 1998

Note: Based on Willamette NF Annual Reports 1953-1972 and 1988-1997.

However, lands suitable for timber harvest declined by 75% when the 1990 Willame Forest Plan was amended by the NW Forest Plan. As a result, the road maintenance budget (along with the timber program) declined substantially within a short timefra

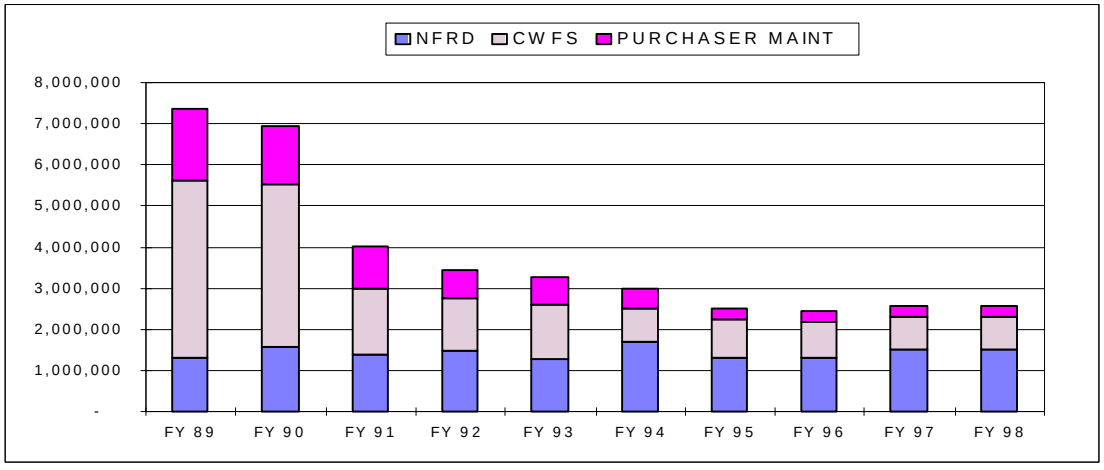


Figure 3 shows a funding decline of $4MM in three years ($7.25MM in 1989 to $3.25MM in 1992). This was largely due to the rapid decline of CWFS (Cooperative Work Forest Service) trust funds, which were funded by deposits generated from log haul. Despite the substantial decrease in traffic volume related to log haul, road maintenance associated with erosion, sedimentation, brushing, and public safety remains.

The current annual road maintenance budget is about $2.4MM *(see*

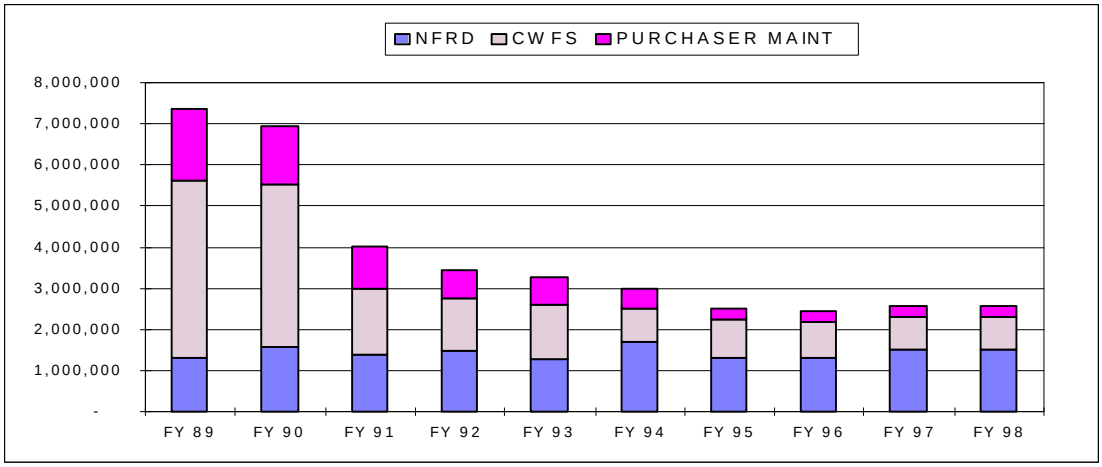
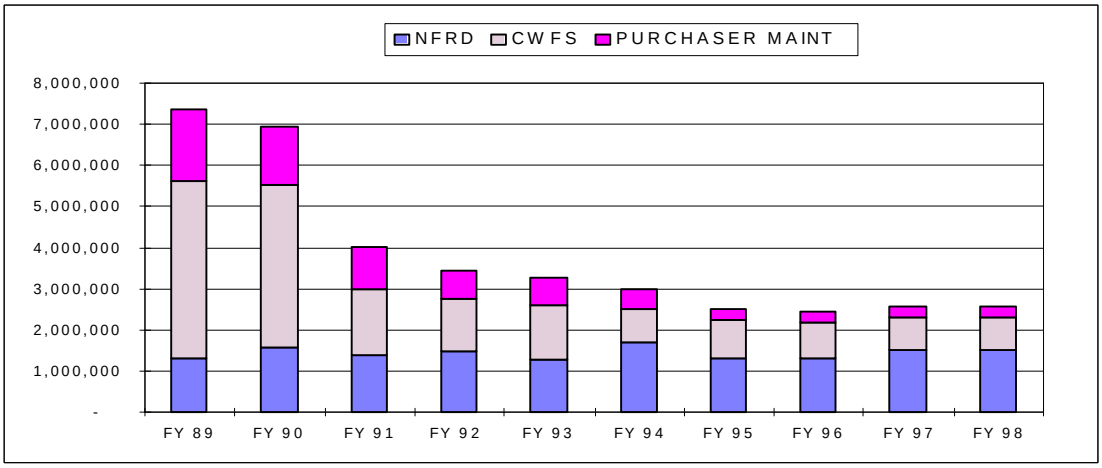


Figure 3*)*. Overhead costs reduce this by nearly 40%, leaving $1.4MM actually available to perform annual road maintenance.

Figure 3. Road Maintenance Funding Levels



6.2.2. Estimated Annual Maintenance Costs

Due to substantial costs associated with reducing the Forest road system, Forest Development Road miles have not decreased significantly since 1989 (*see*

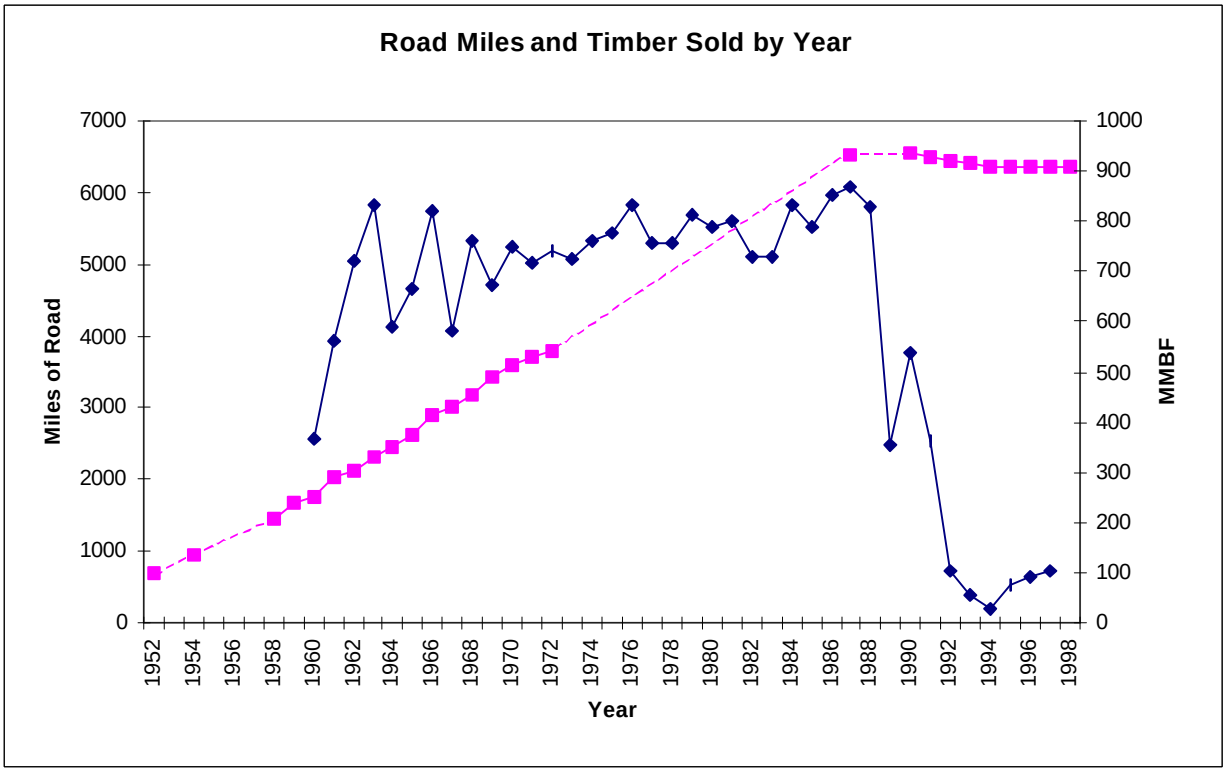


Figure 2). A decline in maintenance budgets without a corresponding reduction of road miles has lead to insufficient funding to maintain the road system in a safe and environmentally sound condition.

Table 4 shows that an estimated $3.4MM per year is needed "on the ground" to perform the necessary annual maintenance. Total funding to the Districts is $1.4M per year, leaving an estimated "on-the-ground" budget shortfall of $2M per year.

Table 4. Estimated Annual Maintenance Costs for Road Maintenance to Standard

Maintenance Level	Low Cost/mile	High Cost/mile	Average Cost/mile	Total Funding Needs	Total Funding to Districts	Funding Shortfall
1 (736 miles)	$25	$75	$50	$36,800	$1,400,000 to perform maintenance for all roads	Distribution to Districts
2 (4,067 miles)	$100	$400	$250	$1,016,750		
3 (1,191 miles)	$500	$1,500	$1,000	$1,191,000		
4 (124 miles)	$800	$3,000	$1,900	$235,600		

5 (246 miles)	$2,500	$5,000	$3,750	$922,500		
Total Annual Maintenance Costs				**$3,402,650/yr**	**$1,400,000/yr**	**-$2,000,000/yr**

Estimated funding to fully maintain the primary/secondary road network (key travel routes identified by the Forest to remain open on a long-term basis) is $2M. If the entire current road maintenance budget were used to fully maintain the primary/secondary road system, this network would still be underfunded by $1M.

Note: Note that this estimate does not include overhead costs, deferred maintenance or capital improvement needs. It is based on current contract costs and district force account costs for annual maintenance.

6.2.3. Road Decommissioning Costs

Preliminary estimates indicate that the Forest is under-funded by more than 50% to maintain the road network to full standard. Over 3,000 miles of the Forest road network would have to be reduced to a near self-maintaining condition (or zero maintenance cost) to be in line with current funding levels. Typical costs for decommissioning (based on contract estimates) for the average road range from $5,000 to $15,000 per mile. Thus, on-the-ground costs to decommission 3,000 miles of forest development roads could be in the $30,000,000 range. This cost does not include planning, public involvement or NEPA (National Environmental Policy Act) related analysis.

6.3. Management Direction

6.3.1. Forest Service Manual

The Forest Service Transportation System is addressed under Title 7700 of the Forest Service Manual (FSM) (USDA 1994). National Forests are directed to have a current forest development transportation plan. Objectives of the transportation system are to provide access to National Forest System lands in order to accomplish management direction and protection objectives while also providing user safety, convenience and efficiency of operations, and minimizing total life-cycle costs of roads. All transportation activities should be integrated with land and resource management planning, incorporating interdisciplinary and cost-effective input to the transportation planning and design process. In addition, Forest Supervisors are directed to “ensure that project development and operation is based on and is consistent with transportation plans”. An area transportation analysis tiered to the Forest Plan is required prior to any development in released inventoried roadless areas.

Economic considerations are important in determining the cost effectiveness of a transportation system. A network analysis establishes various costs of a road system: fixed development costs, variable user-related costs for a resource activity, and the cost of operating and maintaining the network. Roads should be designed economically, while “meeting management direction for resource and environmental protection, development and management of tributary lands, and utilization of the resources”. Equal consideration should be given to safety, impacts on land and resources, and the cost of transportation.

Transportation systems should be evaluated in the context of the ecosystem(s) in which they are located and environmental protection requirements associated with road construction should be identified.

It is important to realize that "forest development roads are not public roads in the same sense as roads under the jurisdiction of public road agencies, such as states or counties. Forest development roads are not intended to meet the transportation needs of the public at large. Instead, they are authorized only for the administration and utilization of National Forest System lands. Although generally open and available for public use, such use is at the discretion of the Secretary of Agriculture. Through authorities delegated by the Secretary, the Forest Service may restrict or control use to meet specific management direction. Commercial users, permittees or contractors may also be required to share in the cost of developing, improving and maintaining forest development roads."

Options for managing traffic on roads are to: encourage, accept, discourage, eliminate, or prohibit use.

6.3.2. Northwest Forest Plan

The following direction is taken from the Standards and Guidelines, Attachment A to the Record of Decision for the Northwest Forest Plan.

6.3.2.1. Roadless Areas and Key Watersheds

To protect the remaining high quality habitats, no new roads will be constructed in inventoried roadless areas in Key Watersheds. Watershed analyses must be conducted in all non-Key Watersheds containing roadless areas before any management activities can occur within those roadless areas.

The amount of existing system and non-system roads within Key Watersheds should be reduced through decommissioning. Road closures with gates or barriers do not qualify as decommissioning or a reduction of road mileage. If funding is insufficient to implement reductions, there will be no net increase in the amount of roads in Key Watersheds. That is, for each mile of new road constructed, at least one mile of road should be decommissioned, with priority given to roads that pose the greatest risks to riparian and aquatic ecosystems.

6.3.2.2. Late Successional Reserves

Road construction in Late Successional Reserves for silvicultural, salvage and other activities generally is not recommended unless potential benefits exceed the costs of habitat impairment. If new roads are necessary to implement a practice that is otherwise in accordance with these guidelines, they will be kept to a minimum, be routed through non-late successional habitat where possible, and be designed to minimize adverse impacts. Alternative access methods, such as aerial logging, should be considered to provide access for activities in reserves.

6.3.2.3. Riparian Reserves

In order to meet Aquatic Conservation Strategy objectives, existing and planned roads should meet the guidelines identified in RF-2 and RF-3:

- Road and landing locations should be minimized in Riparian Reserves
- Watershed analyses should be completed prior to construction of new roads or landings in Riparian Reserves
- Minimize disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flow
- Restrict sidecasting as necessary to prevent the introduction of sediment to streams
- Avoid wetlands entirely when constructing new roads
- Reconstruct roads and associated drainage features that pose a substantial risk
- Prioritize reconstruction based on current and potential impact to riparian resources and the ecological value of the riparian resources affected
- Close and stabilize, or obliterate and stabilize roads based on the ongoing and potential effects to Aquatic Conservation Strategy objectives and consider short and long term transportation needs.

Guideline RF 4 requires that new culverts, bridges and other stream crossings shall be constructed, and existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associate bedload and debris. Other requirements of the road system are to: minimize sediment delivery to streams from roads (RF-5) and provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams (RF-6). Guideline RF-7 directs the development and implementation of a Road or Transportation Management Plan which would include following:

- Inspections and maintenance during and after storm events
- Traffic regulation during wet periods to prevent damage to riparian resources
- Development of the Road Management Objective to establish the purpose of each road.

Guideline MM-2 directs the location of "…roads outside Riparian Reserves. Where no alternative to siting facilities in Riparian Reserves exists, locate them in a way compatible with Aquatic Conservation Strategy objectives."

6.3.2.4. Matrix

One final point of note is found in the section on lynx, where it is indicated that since roads provide access to hunters and trappers, road density may be related to lynx mortality.

6.3.3. Willamette Forest Plan

The following direction is taken from Chapter IV, Forest Management Direction of the Willamette Forest Plan 1990b).

6.3.3.1. Strategic Goals

The strategic goal for Forest management of travelways is to provide visually pleasing and efficient access for the movement of people and materials involved in the use, protection and management of forest lands.

6.3.3.2. Desired Future Condition

The desired future condition (ten years from 1990) includes the construction of approximately 400 miles of new roads, primarily to provide access for timber harvests. While some of these roads would be constructed in currently roaded areas, the expectation at the time was that others would "enter several hundred acre blocks of mature stands within general forest allocations." In addition, the plan called for the reconstruction of 1,740 miles of road in conjunction with timber harvests and recreation management. In some cases, reconstruction projects would correct or alleviate erosion and road stability problems and provide for safe public access.

The projection for 50 years (approximately 2042) was that "many roads will be maintained for timber harvest and public access, while others will be closed during certain times of the year or for certain uses to enhance wildlife habitat and to protect soil and water resource values."

6.3.3.3. Resource Programs and Standards and Guidelines

Interdisciplinary coordination is an essential part of road system management. In terms of resource objectives, rehabilitation or improvement of road stability, soil productivity, water quality, and stream channel stability is an integral part of the soil and water program. Existing roads contributing sediment to streams should be considered for reconstruction to stabilize surfaces, fills and drainage structures (FW-097). Drainage structures should be inspected annually unless identified as low risk (FW-100). Temporary roads should be closed as part of the project work (FW-101, FW-314) and permanent drainage structures removed (FW-102, FW-315). When water quality objectives for water temperature, turbidity and sediment levels cannot be met, enhancement projects should be implemented (FW-114).

Improving the conditions and quality of big-game habitat can be accomplished by emphasis on management of cover quality, forage quality, and open road density. Management practices such as road closures and seasonal restrictions can be used to enhance big-game habitat (FW-141-144). Closures would generally be located on dead end spur roads. Few collector roads are expected to be closed (FW-141).

Vegetation control should be considered along Forest roads (FW-258).

Recreation access should be retained for developed campsites, established old-growth groves, trailheads, and special interest areas. Road closures or access restrictions shall consider the effects on developed and dispersed recreation sites and trailheads. Proposed access restrictions will consider season of use, alternate routes and availability of similar experiences (FW-313). Integrated trail and transportation system planning should minimize existing and future road crossings and other trail/road related conflicts (FW-036). Displacement of Forest trails by new roads should be avoided wherever possible (FW-040).

The Forest Plan provides for the continued development, maintenance and management of the Forest development road system (FW-308). Forest roads shall be located, designed, constructed, and reconstructed based on the following criteria: resource management objectives, environmental needs, safety, traffic requirements, traffic service levels, vehicle characteristics, road users, season(s) of use, and economics (FW-309). Major through-roads, most commercial haul routes, roads in and to developed recreation or administrative sites, and roads leading to moderate or high-use trailheads, should be maintained for low-clearance vehicles (Maintenance Levels 3, 4 and 5) (FW-310). Temporary roads left from past activities should be evaluated as they are encountered during project environmental analysis and rehabilitated as soon as practicable (FW-316).

8. Issues and Key Questions

This chapter identifies road-related issues in the analysis area. In general, *roads* refers to National Forest Development Roads, unless otherwise specified. Most of the Issues and underlying Key Questions are purposely framed as questions to help identify the information and analysis methods that are most appropriate to address the issue. Not all issues are best addressed at the forest-level scale of analysis. Recognizing this, the road analysis team has indicated which scale or scales of analysis was most apropos for each issue and key question. Watershed and project scale issues are included in this list to recognize their importance, but they will not be addressed in this Forest-level analysis.

Note: Some Key Questions correspond to Questions found in the National Forest Road Analysis document Appendices; these are listed in parentheses.

8.1. Economics

1. **How does the road system affect the direct costs and direct revenues to the Agency used in assessing financial efficiency?** (EC 1) *How do we address this at the Forest level?*
2. **What is the Net Public Benefit of the forest road system?** (EC 2) *(NEPA decision levels)*
3. **What are the maintenance costs of the existing road system? How does that compare to recent forest road budgets and projections of future forest road budgets?** *Forest scale*

8.2. Aquatics and Water Quality (AQ)

1. **How, when, and where do roads affect water quality?** [includes sedimentation from both surface erosion and potential increases in mass movements (such as debris avalanches and debris flows) and potential impacts to toes of earthflows producing fine-grained sediments.]

Key Questions

- How and where does the road system affect fine sediment that enters streams, lakes and wetlands? (AQ 1) *Forest scale*
- How and where does the road system affect mass soil movements that affect aquatic or riparian ecosystems? (AQ 2) *Forest and watershed/project scale*
- How and where does the road system modify drainage density which affects water quality and quantity? (AQ 4) *Forest scale and watershed scale*
- How and where does the road system, including all roads on National Forest lands, affect risks to water quality from chemical spills or roadway applied chemicals such as oil, de-icing salts, herbicides, and fertilizers? (AQ 10) *Forest scale*
- How and where does the road system affect wetlands? (AQ 12) *Forest and watershed/project scale*

2. **How and when do roads affect water quantity?** [includes potential increases in peak flows due to interception of subsurface flow, particularly in mid-slope positions, since roads may route water more quickly into stream channels.]

Key Questions

- How and where does the road system modify drainage density which affects water quality and quantity? (AQ 4) *Forest scale and watershed scale*
- How and where does the road system affect movement of groundwater? (AQ 5) *Forest scale*

3. **How and where do roads affect stream geomorphology?** [includes the position of a road or road segment adjacent to a major stream channel. Indicators might be the location of roads in flood plains or adjacent to major streams, where meander patterns may be truncated by a road.]

Key Questions

- How and where does the road system affect key interactions between aquatic and terrestrial systems? (AQ 8) *Forest or larger scale and watershed scale*
- How and where does the road system alter the storage capacity of stream channels for coarse woody debris, sediment and organic matter? (AQ 9) *Forest Scale and watershed scale*
- How and where does the road system affect channel structure and geometry, and isolation of floodplains from their channels? (AQ 11) *Forest scale and watershed scale*

4. **How, when and where do roads affect riparian functions?** [includes the presence of roads in riparian areas and Riparian Reserves (Northwest Forest Plan). This issue is very closely linked with similar issues and key questions for fish and wildlife populations and habitat.]

Key Questions

- How and where does the road system affect mass soil movements that affect aquatic or riparian ecosystems? (AQ 2) *Forest and watershed/project scale*
- How and where does the road system affect movement of groundwater? (AQ 5) *Forest scale*
- How and where does the road system affect key interactions between aquatic and terrestrial systems? (AQ 8) *Forest or larger scale*
- How and where does the road system affect channel structure and geometry, and isolation of floodplains from their channels? (AQ 11) *Forest scale and watershed scale*
- How and where does the road system affect wetlands? (AQ 12) *Forest and watershed/project scale*

8.3. Fisheries

1. **How and where do roads affect fish populations?**

Key Questions

- How and where do roads affect fish spawning/production areas? *Forest and watershed scale*
- How and where do roads restrict fish access to suitable habitat? *Forest and watershed scale*
- How does the use of roads affect fish mortality, especially Threatened, Endangered or Sensitive species? (*e.g.*, anglers, swimmers, poaching, fish roadkill, etc.)

2. How and where do roads affect fish habitat?

Key Questions

- How and where do roads affect meeting state water quality standards for stream temperature? *Forest and watershed scale*
- How and where do roads restrict fish access to suitable habitat? *Forest and watershed scale*

8.4. Terrestrial Wildlife

1. How and where do roads help to create, remove and/or affect different types of available habitat?

Key Questions

- Where are the priority areas and habitats of concern? (TW 1) *Forest scale*
- How and to what extent do roads affect late-successional and interior habitat? (TW 4, TW 5) *Forest scale*
- How and where do roads affect special and unique habitats (*e.g.*, caves, cliffs, meadows)? (TW 7) *Forest and project scale*

2. How and where do roads affect the quality or functionality of existing habitat (*e.g.*, connectivity)?

Key Questions

- How and where does the road system affect the removal of habitat structural components (*e.g.*, hazard tree/snag removal along roads)? (TW 10) *Forest scale*
- How and where do roads restrict habitat connectivity? (TW 5) *Province, Forest and watershed scale*

3. How do roads impact wildlife objectives in reserved lands (LSRs, Riparian Reserves, Administratively Withdrawn Lands)?

Key Questions

- Which late successional related species are affected by roads and how are they affected? *Forest scale*
- What are the current road densities in reserved lands? *Forest scale*

4. What impact do roads have on animal populations or individual animals?

Key Questions

- How and where does the road system (including all roads on Forest lands) affect direct mortality (*e.g.*, road kill, legal and illegal hunting)? (TW 8, TW 9) *Forest and watershed/project scale*
- How do road maintenance chemicals (de-icers, road oils) used on all roads affect wildlife? Which chemicals have adverse affects? *Forest scale*
- How and where does the road system (including all roads on Forest lands) affect the predation rates on certain populations? *Forest scale*
- Where does the current open road densities exceed Forest Plan objectives for big game? *Forest scale*

5. How and where do roads affect Threatened, Endangered and Sensitive species and other species of concern (*e.g.*, Survey and Manage, Protection Buffer)? (TW 6)

Key Questions

- How, when and where does the road system affect TES habitat due to the proximity of roads to key habitat such as nesting and roosting, denning and foraging areas? *Forest scale*
- How and where do road-related human activities (special forest product, firewood collecting) affect TES species (*e.g.*, disturbance)? *Forest scale*

8.5. Botanical

1. How do roads remove/destroy/change plant habitats?

Key Questions

- How and where do roads affect special and unique habitats (*e.g.*, meadows and rock gardens)? *Forest and project scale*
- How do roads impact reserved lands (Late Successional Reserves and Riparian Reserves) which are habitat for rare and unique species?
- What late successional related species are found adjacent to roads and how is their habitat affected? *Forest scale*

2. How and where do roads affect sensitive plant species and other plant species of concern?

Key Questions

- What species are located in habitats with high probability of impact from road building and quarries?

3. How does road maintenance, construction and obliteration contribute to movement of noxious and undesired non-native plant species?

Key Questions

- How and where do roads and their use contribute to spread of exotic species, i.e. noxious weeds? (EF 1)*Forest scale*

8.6. Fire and Fuels

1. How do roads affect the efficiency, costs, effectiveness and safety of fire protection/suppression?

Key Questions

- How and where do roads contribute to fire suppression, i.e. access to areas with high fuels loading, high resource values?*Forest scale*
- How and where do roads provide fire breaks in areas of high fuel loading?*Watershed or project scale*
- How and where do roads contribute to fire suppression safety, i.e. escape routes, safety zones? (PT 2)*Watershed or project scale*
- How and where do roads provide access to fire suppression resources, i.e. water sources, helispots?*Watershed or project scale*

2. How do roads affect the risk of fire occurrence (starts)?

Key Questions

- Which roads have a high amount of use and are coincident with fuel types and fuel loadings that increase risk of large fires?*Forest scale*
- How do fuel type changes immediately adjacent to roads increase probability of human-caused fire starts and spread?*Watershed or project scale*

3. How does the road system affect the efficiency, costs, effectiveness and safety of fuels management?(PT 1)

Key Questions

- Where does the road system provide access to areas of high fuel loading and how does access affect per acre treatment costs?*Forest and watershed scale*
- How does the road system contribute to fuel breaks, block planning for prescribed burning?*Watershed or project scale*

4. How do forest roads affect fire protection/suppression in the urban interface?

Key Questions

- Where do forest roads play a key role in providing adequate ingress/egress for the public and fire suppression forces? (PT 2)*Forest, watershed and project scale*
- Are current maintenance levels consistent with fire suppression and protection objectives in interface areas?*Forest and watershed scale*

- Do any forest roads play a role in local (city, county) contingency plans for fire suppression access and/or public evacuation routes? (PT 2) *Watershed and project scale*

8.7. Forest Products

1. How do roads provide for the management of forest products in Matrix and Adaptive Management Areas? (TM 2)

Key Questions

- How much of the area that is suited and available for timber management is accessed by the existing road system and can be logged using conventional yarding systems? *Forest and watershed scale*
- Which suited and available areas are not accessed by the existing road system? (TM 2) *Forest and watershed scale*
- How does road spacing and location affect logging system feasibility? (TM 2) *Watershed scale*
- How does existing road access affect commercial and personal collection of nontimber forest products? (SP 1) *Watershed and project scale*

2. How does the road system affect silvicultural/vegetation treatment needs? (TM 3)

Key Questions

- Does the existing road system provide access to areas needing silvicultural treatments, i.e. planting, release, thinning? *Watershed scale*
- How does road access affect the cost and efficiency of different types of silvicultural treatments? *Forest and watershed scale*

8.8. Recreation

1. Is there now or will there be excess supply or excess demand for unroaded recreation opportunity? (UR 1)

2. What is the level and condition of access to developed recreation sites, trailheads and Special Interest Areas? (RR 4, RR 5) (*e.g.*, some trailheads may have more access roads than needed.)

3. How and where does the existing road system influence recreation areas?

Key Questions

- Does road access contribute to use in excess of the capacity of recreation facilities? (*e.g.*, trailheads, wilderness, wild & scenic rivers, etc.) *Forest and watershed scale*

4. Does the number of roads and/or their condition influence use patterns and qualities of back-country destinations? *Watershed scale*

Key Questions

- Does road access (number of roads and road condition) contribute to overcrowding and/or resource damage at popular back-country destinations (wilderness, Wild & Scenic Rivers, dispersed sites, trailheads)?

5. How and where does the current road system meet motorized, driving for pleasure recreation demands?

Key Questions

- Where are Scenic Byways, Backcountry Byways and other designated recreation-related travel routes? *Forest scale*
- Which forest roads provide loop opportunities desired by 4-wheel groups (street-legal 4-wheel drives)? *Forest and watershed scale*
- What opportunities exist for converting closed roads to ATV trails? (RR 10)

8.9. Heritage Resources

1. How and where do roads provide access for traditional cultural practice sites for Native Americans? (SI 4)

Key Questions

- Is limited or selective access to some sites preferred by Native Americans? *Forest and project scale*
- Are roads adversely impacting cultural practices and where? *Watershed and project scale*
- Which areas are desirable for full access? *Forest and project scale*

2. How and where does road access affect archeological sites and historic properties? (SI 3)

Key Questions

- Are archeological sites and historic properties adversely affected by the existing road system? (*e.g.*, maintenance, operation and use) *Forest, watershed and project scale*
- How does the existing road system contribute to the efficiency and costs of maintaining historic properties? *Forest and watershed scale*
- How does the existing road system contribute to interpretation and public use of historic sites or other cultural resources? *Forest and watershed scale*

3. Which roads are historic transportation routes? (SI 5) *Forest scale*

Key Questions

- Where have historic transportation routes been identified and how does maintenance to historic levels affect other resources? (*e.g.*, Oregon military road and Santiam Wagon Road)

8.10. Social

1. **How might changes in road management affect people's dependence on, need for, and desire for roads and access?** (SI 1&2)

Key Questions

- How and where does the road system connect to other public roads and provide primary access to communities, rural residences and businesses? *Forest and project scale*
- What "personal use" activities are commonly associated with forest development roads (*e.g.*, firewood gathering, berry picking, Xmas tree cutting, etc.)? *Forest and project scale*
- How and where would people's sense of place (and favorite places) be affected? (SI 11) *Uncertain of what scale is possible*

2. **How can we communicate about road management in a manner that is experienced as open, honest and reliable?** (SI 6)

Key Questions

- What forms of communication are viewed as most effective?
- What media do most people feel comfortable with?
- What public participation efforts have been effective? *Forest scale*

3. **What are effective ways to solicit, elicit and gather information from interested and/or affected publics?**

Key Questions

- What collaborative processes have taken place that facilitated decision-making? At what scale?

4. **How and where would changes in the road system, or management thereof, affect certain groups of people (*e.g.*, minorities, ethnic, cultural, racial groups, persons with disabilities, low income groups)?** (CR 1)

Key Questions

- What are the usage patterns of potentially affected groups? *Forest/District scale*
- What opportunities exist to improve or better facilitate use by potentially affected groups? *District scale*
- Has the Executive Order on Environmental Justice been considered in the decision?

5. **How would overall community (of place) economic health be affected by changes in forest development roads?** (SI 7) *Community scale*

Key Questions

- What is the economic composition of community?
- To what extent is community dependent on extractive, commodity forest resources (timber, mining, grazing, etc?)?

- To what extent is community dependent on amenity forest resources (recreation, tourism, etc)?
- What role do roads play in the changing economics of rural communities? (SI 17)

6. **How might overall community (of place) satisfaction be affected by changes to the forest development road system?** (SI 13) *Community scale*

Key Questions

- How cohesive is the community? What lifestyles are represented in the community?
- How resilient is the community? How does the community respond to change?

7. **What is the perceived economic dependency of a community on a roadless area versus the value of that roadless area for its intrinsic existence and/or symbolic value(s)?** (SI 8) *Community scale*

Key Questions

- What are the significant existence and/or symbolic values of the community?
- What is the community lifestyle?
- What values are being asserted from outside the community?

8.11. Lands

1. What is the level of road access to private inholdings (cost-share roads) and what are the physical, biological and social impacts? (GT 2)

Key Questions

- Which inholdings are likely to require or be the source of requests for future access? *Forest scale*
- Are there alternative routes or options for access to private inholdings where current access is creating adverse impacts? *Watershed or project scale*

2. What is the level of road access to lands managed by other federal agencies or the state? (GT 3)

3. What is the level of road access to easements/special use permits, recreation summer homes, mining claims, administrative sites (*e.g.*, gravel), etc.? (SU 1)

8.12. Roadless

1. **What is the amount and location of unroaded areas on the Forest by stratified by size of area and Forest Plan land allocation?** *Forest scale*

Key Questions

- Where are significant aquatic, terrestrial wildlife or ecological values associated with unroaded areas? *Forest and watershed scale*

9. KEY RESULTS

9.1. Economic

9.1.1.1. Introduction

The history behind the Willamette's current road system has an important role in how we consider its financial efficiency. The Forest's roads were built primarily to access timber harvest units and for other administrative purposes. High timber revenues coupled with recreation benefits and access for firefighters made the roads financially efficient to build and maintain.

In 1994, the Northwest Forest Plan was implemented with the result that more than 75% of the timber suited lands once available for timber harvest are now in no-harvest land allocations. With this series of events, the primary source of revenue that maintained the current road system fundamentally changed. The objective of the economic questions is to address costs, budget and overall financial efficiency of the current road system.

9.1.1.2. Results and Interpretation

The cost of maintaining the current road system at its prescribed maintenance level is approximately $3.4 million dollars. Approximate expenditure to maintain roads located in matrix lands is $1.8 million; where no programmed timber harvest is planned the cost is $1.3 million. Roads located on private land are expected to cost approximately $248,000 a year.

When revenues from commodity harvest are compared to road maintenance costs, costs on harvestable lands are well below the revenues they generate. This is also true for non-harvestable lands over the next decade as commercial thinning continues to promote late-successional conditions. However, most roads in areas of no-harvest (primarily LSRs) and private land will not financially pay for themselves after the next decade.

Regardless of sufficient timber revenues, the road maintenance budget does not fund roads to prescribed maintenance levels. Continuing to maintain the road system as efficiently as possible within current budget levels, will eventually result in roads that are neither environmentally sound nor maintained to a level safe for users. Decommissioning roads provides an opportunity to make an initial investment and reduce future long-term maintenance costs. Decommissioning a sufficient number of roads will bring our current maintenance costs in alignment with the budget.

The financial efficiency of reducing road maintenance costs by decommissioning was analyzed. Three scenarios were considered: road decommissioning, road closure and continued road maintenance. The results indicate that ***a one-time investment of dollars to decommission roads strictly to bring the road system in alignment with the current budget level is not recommended under current decommissioning costs.*** There will, however, be roads that need to be decommissioned because they pose environmental costs that qualify them for decommissioning.

It is important to note that external costs were not included in this analysis. An external cost is one caused by the agency and imposed on another party without compensation, such as polluting water or degrading scenic beauty. In this same vein, external benefits such as enhanced property values were also not investigated. Estimation of future revenues from timber harvest include both harvest and no-harvest allocations.

9.2. Ecological

9.2.1. Aquatics and Water Quality

9.2.1.1. Introduction and Issues

There are four principle ways in which roads interact with and affect watershed resources and processes in the westside Cascade Mountains of the Pacific Northwest Region.

1) Roads interact and influence the production of both fine and coarse textured sediment, thus influencing water quality.
2) Their position on steep hillsides often intercepts and daylights subsurface flow, routing such flow more quickly to adjacent stream channels, thereby potentially increasing peak flows.
3) Road location within riparian reserves can influence the meander patterns of adjacent streams effecting a stream's ability to move its sediment.
4) Roads within riparian reserves potentially affect a host of processes and resources associated with these reserves, such as the availability of large wood, access to streams by recreationists, and movement of wildlife from upland areas to and through riparian areas.

Four general areas define the broad issues associated with watershed processes:

1. Water Quality
2. Water Quantity
3. Geomorphic (position of a road or road segment adjacent to major stream channels)
4. Riparian

9.2.1.2. Findings and Results

The amount of fine sediments produced by the road system that enter streams, lakes and wetlands was addressed by combining mapped Quaternary Landslides (earthflows) with stream and road locations. The distribution of this combination indicates potential areas of concern for the production of fine sediment. Watersheds containing a high percentage of area in this combination are: The North Santiam River – Blowout to Woodpecker; South Fork McKenzie River; Salmon Creek; and Upper Middle Fork Willamette River.

Soil mapping units (SRI) designated as "unstable" and "potentially unstable" were mapped to show areas that could become involved in surficial landslides, debris flows and debris torrents. It would be appropriate to analyze these in combination with road density. In this case, the hazard would increase with higher road densities within each category. Due to time limitations, these areas were not defined.

Culvert and bridge crossings affect streams and drainages in a watershed by constricting flows during periods of high runoff. They are often the focus points for damage from culvert plugging and subsequent road failure. A map of road and stream intersections was developed to address this issue. It was determined that this information, although vital to road management decisions, would most appropriately be considered at a smaller scale of analysis.

A combination of road mileage with slope position (mid-slope and valley bottom) in riparian reserves was developed in order to assess the impact of roads on potential increases in peak flows by interception of subsurface flow and more efficient routing of water to channels. The average percent increase was 17.1% in valley bottom stream miles and 17.6% on mid-slopes. This means that the active stream network during high flow events is increased by an average of 17.1-17.6%, which would increase the amount of water moving in a channel during a storm event and cause the hydrograph to peak more rapidly. Increased channel erosion locally and downstream could result from such changes. As road density increases, the active stream network increases. Thus, the higher percent increase in roads within riparian reserves, the greater the possibility of stream channel degradation.

9.2.2. Fisheries

9.2.2.1. Introduction

Roads influence the health and distribution of aquatic species on National Forest System lands by several mechanisms:

a) Impacts to riparian areas may result in loss of streamside shade; loss of near-stream vegetation; compaction or loss of floodplains; destabilization of steep slopes adjacent to streams; poaching; vandalism; and litter.

b) Impacts to stream channels due to road construction may lead to excessive fine sediment entering stream channels.

c) There is an increased risk of impacts by roads to stream channels and aquatic species due to road management such as road age, type of surface material, or number of stream crossings.

Two main issues directly related to fisheries were identified: road impacts on *fish populations* and *fish habitat*. In the Pacific Northwest, the focus is on salmonid spawning and rearing, and whether or not the population status of a species is known.

During analysis, the status of fisheries was lumped into the following categories:

- **T&E occupied:** when bull trout, winter steelhead, spring chinook, or Oregon chub (or a combination of these species) occur in the subwatershed and the subwatershed is used primarily for spawning/rearing or migration.
- **Historic T&E:** the subwatershed once supported bull trout, winter steelhead, spring chinook, or a combination of these species and was used for spawning/rearing and migration.

9.2.2.2. Results

Subwatersheds currently occupied by bull trout, winter steelhead, spring chinook or Oregon chub were identified, as were watersheds of historic occupation. The latter will be important for consideration during species recovery planning under the Endangered Species Act. These watersheds were compared to other resource "hot spots" to provide a Forest level list of priority areas for road and transportation system management.

Table 1 in the Fisheries Process Paper (Appendix C) highlights sixth field subwatersheds within fifth field watersheds that may be a priority when considering further steps and designing site-specific actions or projects through future ATM and/or NEPA processes.

9.2.3. Terrestrial Wildlife

9.2.3.1. Introduction

The Forest road network can significantly alter wildlife habitats and negatively impact wildlife populations. The negative effects of roads on wildlife can be classified into three general categories: (1) edge effects; (2) barriers to movement; and (c) avenues for resource extraction and human activities.

Edge effects are the result of the interaction between two adjacent habitats, when the two habitats are separated by an abrupt edge (Murcia 1995). The ecology of forest edges is characterized by changes in biotic (parasites, predators and herbivores) and abiotic (microclimate, disturbance regime) elements. If exposure to the edge modifies the features of the forest beyond their range of natural intrinsic variation, then the fragment's area will be effectively reduced for conservation purposes (Murcia 1995).

Forest fragmentation can threaten native wildlife populations by eliminating blocks of continuous habitat or by degrading the quality of remaining habitat for those species sensitive to an increase in the amount of forest edge. Currently, roads and the history of intensive timber harvesting are the major causes of forest fragmentation on the Willamette National Forest.

A second major impact of roads on wildlife is as a barrier to species movement. The barrier effect is sensitive to both road width and traffic density (Forman and Hersperger 1996). As road width and traffic density increase, roads become more effective barriers to movement (Reudiger 1996). When populations become subdivided, there is increased risk of demographic fluctuation, local extinction of subpopulations, less recolonization after local extinction, and a progressive loss of local biodiversity (Soule 1987).

Finally, the extensive network of Forest Service roads also creates opportunities for humans to extract natural resources. Indeed, the construction of the vast majority of the Willamette' road system was to extract timber. In addition to timber harvest, many animals (e.g., deer, elk, and bear) are hunted, and most hunters camp and hunt close to roads. Generally speaking, human influences on the forest are greatest near roads and decrease steadily with distance from roads.

9.2.3.2. Results and Interpretation

High road densities can pose problems for wildlife populations due to biological and abiotic edge effects associated with roads. These effects were summarized by "roadsheds," which are large blocks of land separated by major (state) highways. The state highway system divides the Willamette National Forest into six distinct roadsheds. Since many species do not cross major highways or suffer high mortality rates when attempting to cross them, roadsheds may represent regions into which some populations are subdivided.

The amount of interior habitat varies greatly among roadsheds, from a low of 7.7 square miles in Roadshed 1 (6% of the roadshed) to a high of 60.1 square miles in Roadshed 6 (16%). In each roadshed, over 40% of all the land is affected by edge effects. Edge effects impact 31-49% of current spotted owl habitat and 22-41% percent of interior habitat in the six roadsheds on this Forest *(see Figures 3 and 5, Wildlife Process Paper, Appendix D)*. These statistics indicate that a large percentage of late-successional habitat, upon which many plant and animal species depend, incurs negative impacts from roads.

Areas of concern based on road densities in connected, late-successional habitat were identified. The highest priority are those areas with road densities of 6-8 miles/mi^2. Note that several areas in the highest road density categories are in Late-Successional Reserves (LSRs). Since these areas are managed for late-successional dependent species, it is of concern that some of the highest road densities in connected, late-successional habitat occurs in the LSRs.

Species not dependent on late-successional habitat, such as elk, can also be negatively impacted by high road densities. Of the 53 High Emphasis Areas for big game on the Willamette NF, 26 (49%) have road densities that exceed WNF Land Management Plan objectives. Of the 110 Moderate Emphasis Areas for big game, 36 (33%) have road densities exceeding the objectives. On an acreage basis, 218,493 acres (43%) of the land in High Emphasis Level exceed the objectives, whereas 270,163 acres (29%) in Moderate Emphasis Level exceed the objectives (Table 5). **Map 6** *Road Densities in Big Game Emphasis Areas* displays the Big Game Emphasis Areas where WNF Land Management Plan objectives for big game are not being met.

Table 5. Number of acres exceeding objectives for big game

Big Game Emphasis Level	Total # acres in Emphasis Level	# acres exceeding objectives for Big Game (% of total acreage)
High	508,533	218,493 (43%)
Moderate	930,321	270,163 (29%)
Low	352,025	0 (0 %)

9.2.4. Botanical

9.2.4.1. Background

Historically, roads were built along riparian lowlands and ridgelines due to both economics and feasibility. Roads naturally intersect with special habitats along ridgelines because these

areas are often rocky, with little soil development; factors which favor development of meadows or rock gardens rather than forest. As roads were built through these habitats, fill was often placed on top of the existing habitat. The resulting changes in drainage patterns, changes in soil composition and introduction of noxious weeds from roadside shoulders may cumulatively result in significant alteration of the existing plant community.

Another botanical feature affected by roads is the introduction and movement of noxious weeds. People, animals and machinery move noxious weeds from place to place; roads provide constantly disturbed habitats, devoid of competing vegetation, for establishment of weeds. Weed populations are found along road shoulders, in dispersed campsites, hunting camps, trailheads, timber harvest landings--anywhere there is a ground-disturbing activity.

Road maintenance also contributes to the movement of weed seed, especially along the crest of the Cascades. Knapweed is by far the greatest problem in this area. The largest concentrations of this weed are along the major highway corridors (Hwy 20, 22, 126, and 58). One factor is the movement of seed from cinder pits (waste disposal areas) as it is used to treat icy highways in the winter. Another factor is the large amount of recreational traffic moving back and forth over the Cascade crest.

9.2.4.2. Results and Interpretation

9.2.4.2.1. Special Habitats

A significant number of special habitats have been affected by roads. Table 6 illustrates the percentage of habitats affected by roads using polygons of one acre or larger from all land allocations (including Wilderness and other roadless areas). When analyzed at the watershed level, many of the percentages of habitats impacted are 50% or more.

Table 6. Intersection of Roads with Forestwide Special Habitat Polygons

Habitat Type	Acres Affected By Roads	Total Acres Forestwide	Percentage of Habitats Affected By Roads
Rock garden	25.7	1013.3	2.5
Mesic Meadow	554.3	15703.4	3.5
Dry Meadow	204.7	4344.8	4.7
Shrub	520.6	8067.8	6.4
Rock Outcrop	98	2267.5	4.3
Wet Meadow	124.6	2420.2	5.1
Talus	1151.5	43364	2.6
Pond	15.6	242.2	6.4

9.2.4.2.2. Sensitive Plants

The most commonly affected sensitive plant is *Romanzoffia thompsonii*, Thompson's mistmaiden, found in rock gardens adjacent to roads on Detroit, McKenzie, Middle Fork, and

Blue River Ranger Districts (RDs). Of particular concern to this species is any change in hydrology from maintenance or restoration activities.

Other sensitive plants impacted by roads include *Aster gormanii*, Gorman's aster (grows along ridgeline scree slopes on Detroit and Sweet Home Ranger Districts); *Cimicifuga elata*, tall bugbane (South Santiam watershed where a skid road provides access for grazing ungulates); *Frasera umpquaensis*, Umpqua swertia, (a road bisects its meadow habitat at the headwaters of the Fall Creek drainage); and *Montia howellii*, Howell's montia (found in vernal pools in a trailhead parking lot).

9.2.4.2.3. Late-Successional Species

A number of survey and manage species have the potential to be affected by roads. Of particular importance are the known sites of *Hydrothyria venosa*, an aquatic lichen, and *Racomitrium aquaticum*, an aquatic bryophyte, because of their extreme sensitivity to sedimentation. Populations of *Hydrothyria* and *Racomitrium* located in areas with potential road failures or in areas scheduled for road reconstruction should be considered "hot spots."

9.2.4.2.4. Noxious Weeds

Analysis of noxious weeds using GIS layers focused on new invader populations. Table 6 shows the number of new invaders affected by road corridors. Almost every population of new invaders documented on the Forest is associated with a road.

Table 7. Number of New Invader Noxious Weed Sites Adjacent to Roads

Weed Species	Number of Sites
Spotted knapweed	76
Himalayan and Evergreen Blackberry	55
Meadow knapweed	15
Yellow toadflax	7
False brome	6
Diffuse knapweed	5
Giant knotweed	3
Dalmatian toadflax	1
Houndstongue	1

The number of newly invading weeds located in watersheds throughout the Forest varies. The McKenzie, Willamette Middle Fork Downstream Tributaries, and South Santiam watersheds have the highest density of weed infestations. These areas should be considered "hot spots" for weed infestation. It is recommended that road projects build costs of weed prevention into their budgets, that seeding occur immediately after construction, that vehicles used by contractors be steam-cleaned when moved from infested areas, that only certified weed-free seed be used for revegetation, that only weed free rock sources be used for road construction and that roads be closed wherever feasible to reduce the number of weed travel corridors.

9.3. Social

9.3.1. Fire and Fuels

9.3.1.1. Introduction

Roads have both a positive and negative effect on wildland fire suppression and fuel management on the Willamette National Forest. As a benefit, road networks provide access to water sources, lookouts, helispots, and other fire resources used in fire suppression and fuel management activities. In roaded areas, response time is reduced, thereby increasing firefighter efficiency and effectiveness in suppressing both human and natural fires. Roads also provide barriers or fire breaks for fire suppression and fuels activities. From a safety standpoint, roads provide anchor points for line construction, escape routes and safety zones. In some cases wildland fire strategies have been developed around road networks (USDA 1998).

Forest roads and other forms of transportation systems also have negative impacts, such as an increased risk of human-caused fires. Human-caused fires along roadways throughout most of the Forest have a random distribution. However, there are some public high-use areas with significantly higher human-caused fire frequencies. The majority of these areas were identified along major Oregon state highway corridors and railroad transportation systems within the Willamette National Forest boundary.

9.3.1.2. Results and Interpretation

9.3.1.2.1. Fire Suppression

In 1994, the level of fire suppression efficiency on the Forest was measured by an analytical process known as the National Fire Management Analysis System (NFMAS). Efficiency of transportation by emergency and other vehicles on Forest road systems played a key role in the NFMAS process. Vehicles were utilized as the primary mode of transportation in 87% to 90% of representative fires analyzed. The high utilization of vehicles was primarily due to the high road density on this Forest.

Based on the scope of this pilot road analysis, available data and the timeframe, quantifiable changes to fire protection efficiency and effectiveness were not analyzed. Forest fire managers are planning to recalibrate NFMAS by March of 1999. If travel management is identified as an issue based on current and future road closures, primary suppression response methods will be adjusted.

Safety in relation to travel management on the Forest, along with all other safety considerations, is the highest priority for firefighters and the public. Issues such as road surface type and condition, road clearances, visibility of roadways on corners, maintenance levels, and traffic levels are just a few of the safety issues emergency vehicle drivers encounter when responding to wildland fires. The scope of this analysis (Forest level) was too broad to adequately consider such site-specific information, which is best addressed at the watershed scale of analysis. When safety issues dealing with access and travel management on the Forest cannot be mitigated, other forms of transportation or methods of suppression will be utilized by fire managers.

9.3.1.2.2. Access for Fuels Management

It is anticipated that future fuel management and prescribed burning on the Forest will decline at the project level but may increase at a landscape scale. In the future, if management ignited fires are used to meet wildland fire objectives at an ecological scale, road systems may be utilized to provide effective barriers during the ignition and holding stages of a prescribed burn. At this time, however, this program is still in the planning stage. Again, these are issues best analyzed and managed at the watershed scale of analysis rather than the Forest level.

9.3.1.2.3. Access to Fire Resources

Fire resources are defined as lookouts, helispots, helibases, developed water sources, developed incident base camp locations, radio hill top sites, preattack fire breaks, and other related areas on the Forest. An analysis of these resources was not attempted in relation to access and travel management due to the nature and scope of this analysis.

Helispot, preattack fire breaks and developed water sources should be reviewed at the watershed rather than Forest scale of analysis. Road access to permanent lookouts and radio hilltop sites or trailheads leading to such facilities should be retained and maintained.

9.3.1.2.4. Public Access in Relation to Fire Occurrence

The high density of roads on the Forest have contributed to a higher frequency of human ignitions in some areas (USDA 1998). It can also be assumed that public high use areas have higher then average human ignitions. Greater access to such areas as dispersed campsites, backcountry camping and hunting may contribute to the higher incidence of human-caused fires – up to a point. Areas with the highest road densities are generally highly industrialized and therefore are less appealing to recreationists and hunters as camping sites.

The road density assessment does not indicate a linear correlation between road mile density and human-caused fires on the Forest. Frequency and distribution of human-caused fires may be related to factors other than road densities. At this point, more analysis is needed.

At this time, analysis does not verify the need to alter, close or change road systems based solely on human-caused fire occurrence.

9.3.2. Forest Products

9.3.2.1. Introduction

Roads provide access to the forest for planning, designing and implementing a wide range of timber harvest activities. These same roads provide access for equipment that can perform logging and harvesting operations. They also provide access for people and equipment that complete subsequent vegetation management treatments. In addition, roads provide access to individuals gathering special forest products such as Christmas trees, floral greenery, mushrooms, fence posts, and firewood.

All timber and most non-timber forest products are harvested within 2,000 feet of a road. Most timber comes from within 1,500 feet of a road. Non-timber products, such as firewood and fence posts, are primarily collected within 100 feet of a road.

9.3.2.2. Results and Interpretation

There are 444,577 acres of suitable and available matrix and Adaptive Management Area (AMA) lands within 2,000 feet of a road. Conversely, 15,734 acres of suitable and available matrix lands are not within 2,000 feet of a road.

Any watershed or project area with a significant percent of the area further than 2,000 feet from a road will need to include either road construction or alternative logging systems (such as helicopter or other aerial systems) in project design. Not as readily apparent, however, is the need for logging spur roads to access individual harvest units.

Under the Northwest Forest Plan, streams are surrounded by buffers of up to 680 feet, where no timber harvest is allowed. This tends to constrain timber harvest to narrow slices of land between stream buffers, often requiring short spurs to create feasible logging options. Thus, under the Forest Plan, more miles of road must be constructed to reach the "slices" of land available for harvest.

The total matrix area over 2,000 feet from a road exceeds five percent of the entire watershed acreage in only one watershed (Blue River). This is somewhat skewed by the HJ Andrews Experimental Forest. Three watersheds exceed two percent: South Santiam, McKenzie Minor Tribs and Quartz Creek. All others have less than two percent of the land area not accessed by a road (within 2000 feet).

9.3.3. Recreation

9.3.3.1. Introduction

Maintaining a viable road system is the key to our ability to provide the diverse recreation settings necessary to meet our desired condition as stated in the Willamette Forest Plan. At the same time, the existence and/or condition of roads may contribute to overuse and, ultimately, a diminishment of visitors' recreation experiences.

We seek to identify recreation settings of varying characteristics ranging from large, remote undeveloped areas to small, easily accessed and highly developed sites. The majority of developed recreation sites on the Forest are accessible via double-lane asphalt-paved or double-lane all-weather gravel roads. The existing road system provides very adequate access to all recreation areas, developed and dispersed.

As with recreation sites, the maintenance of a viable road system is a key to providing the diverse recreation opportunities available on the Willamette NF. Two hundred thirty-six (236) trailheads service 1,779 miles of both wilderness and non-wilderness trails. Trailheads are, for the most part, accessed by collector roads, but a few are on main arterials or secondary roads. The road system is adequate for the current public demand for trail access, but during the next 40 years demand will exceed the ability to respond with additional miles of trail and trailheads.

In addition, the Forest has two congressionally designated Wild and Scenic Rivers: the North Fork of the Middle Fork Willamette, and Upper McKenzie. In the Forest Plan, nine river segments were identified that have river-related values meeting criteria for eligibility as Wild and Scenic Rivers. Most of these have an arterial or collector road within the corridor boundary. These roads are likely to be considered essential for recreation.

The Forest also has 44 Special Interest Areas (SIAs) and 34 Old Growth Groves. Many of these are served by arterial or collector roads, but some are not accessed by roads at all.

9.3.3.2. Results and Interpretation

Driving for pleasure is the primary use of the main forest road system on the Willamette NF. There are several Scenic Byways and back-country drives on the Forest.

- McKenzie Pass-Santiam Pass Scenic Byway (McKenzie Bridge to Sisters, Oregon)
- West Cascades Scenic Byway (Estacada to Oakridge, Oregon)
- Diamond Drive (from Oakridge, Oregon along the Middle Fork Willamette River to Lomolo Lake and the Rogue River-Umpqua Scenic Byway)
- BLM/USFS back-country drive (begins at State Highway 20 and the Quartzville Road at the east end of Foster Reservoir; ends at State Highway 22 and the Straight Creek road)

Overuse of roads is not a constant issue on the Forest, although it does occur at some sites, such as Detroit Reservoir, along the McKenzie River and along Fall Creek. The road system provides easy access to all of these areas, but does not contribute adversely to exceeded capacity.

Local roads that disperse use into river corridors may have an effect on vegetation and soil, ultimately contributing to erosion. River Management Plans for the two designated Wild and Scenic Rivers identified the need to close certain local roads. For the eligible rivers, some local roads or non-system roads have been closed over time. Further determination of road closures is best analyzed by the Districts through Watershed Analyses or a Level of Acceptable Change (LAC) process.

In general, there are no “hot spots” relating to Wild and Scenic Rivers, Special Interest Areas and Old Growth Groves that should be addressed at the Forest level during this analysis. There may, however, be opportunities to consider the number of local roads within Wild and Scenic River corridors and/or leading to SIAs or Old Growth Groves if they are concurrently identified as contributors to the decline of other resources, such as fish, wildlife or water quality.

In terms of trail access, a forest-wide trailhead map was generated by GIS. Several trailheads fell into areas that are considered “hot spots” in regards to other resources. Focus of analysis should be placed on these trailheads first, to determine whether they are in the best location for visitor needs with emphasis on resource protection. These trailheads are listed in the Recreation Process Paper (Appendix H).

Recreation use in semi-primitive unroaded areas of the Forest is predicted to exceed the practical capacity for that setting between 2010 and 2040 (USDA 1990b). We have no better data than this (Forest Plan) to address future roadless area demands.

There are no known use or access issues at the Forest level. The evaluation of this question is best completed at the District level during the Area Plan or Watershed Analysis processes.

9.3.4. Heritage Resources

9.3.4.1. Introduction

*Heritage Resources*include many forms of archaeological, historical, and cultural properties.

*Archaeological sites*typically exist in the form of buried deposits of stone tools and debris resulting from tool manufacture. Road construction, maintenance, road use, and associated erosion can destroy or damage the integrity of archaeological deposits.

*Historic sites,*in contrast, exhibit a broader range of artifact types, materials, and features in their assemblages. They often include structures as a dominant component, though an archaeological component may also exist. Historic properties also include engineering features and travel corridors, such as early roads, trails, railroad routes, monuments, dams, and bridges. Often modern roads were developed over historic transportation routes.

*Cultural properties*are considered to be locations of traditional cultural activities of indigenous people and their descendants, and may not manifest themselves with distinguishable physical remains. Some tribes have reserved certain rights which must be recognized and access accommodated in land management decisions.

Currently the Willamette National Forest works with four federally recognized tribes who have ancestral ties to the land we manage. These are the Confederated Tribes of Grand Ronde Community of Oregon, the Confederated Tribes of the Siletz Indians of Oregon, the Confederated Tribes of the Warm Springs Indians, and the Klamath Tribe. Of these, only the Warm Springs and Grand Ronde assert claims to ceded lands within the Forest's bounds.

9.3.4.2. Results and Interpretation

It is well known that many archaeological sites on the Forest have been directly impacted by initial road construction, continued road maintenance, and erosion, which results in irretrievable data loss when unmitigated. In order to analyze the effects of the current road system on archaeological sites and historic properties it would be necessary to correlate the locations of each and examine site-specific information for evidence of impacts. Over 2,000 archaeological sites have been documented on this Forest.

Using existing data to conduct an analysis of road system effects on archaeological sites would require the comparison of site locations obtained from these records with the current road system. A cumbersome and time consuming process, analysis would best be accomplished at a district or watershed scale, where more site-specific information is available.

On the other hand, historic sites (especially structures) are more conducive to adaptive uses such as interpretation and recreation rental opportunities, so access for interpretation as well as maintenance may be more desirable in some cases.

Currently, 74 historic structures are listed on the Forest inventory. Comprehensive specific data on maintenance efficiency and costs are not readily available, but may be obtained by a record search and interviews, primarily at the district level.

As a general rule, historic properties with road access have been more often utilized and more efficiently maintained. Exceptions to this are properties accessible by road (or roads and short trails) but located some distance from a ranger station. Often these properties are the target of public abuse and vandalism. Costs associated with maintaining these properties are relatively high. Typically, archaeological sites found on this Forest would not require maintenance unless the site has been impacted by other management or public activities.

Interpretive efforts are generally focused in areas of high public use. Interpretive panels are currently found along many main travel routes and in recreation sites. Interpretation of more fragile archaeological sites takes the form of off-site interpretation, such as brochures or displays. Historic sites currently utilized for recreation or interpretation are listed in the Heritage Resources Process Paper in Appendix I.

Many historic transportation routes, such as old wagon roads, trails and railroad routes, have been adversely affected by road development. As transportation systems evolved over time, modern roads often followed existing historic routes. In some areas, this resulted in obliteration or fragmentation; however, some pristine segments have survived. Some current roads could be closed and routes rehabilitated to a historic character; some could be converted into interpretive trail routes.

Using district computer databases, a list of archaeological sites and historic properties with documented impacts from (1) road maintenance or (2) road or bridge construction was generated. Due to technical difficulties accessing some district databases, only about half of the districts were represented in this list. Of these, there were 86 incidences of sites impacted by road maintenance and 312 sites impacted by road or bridge construction. A simple analysis shows that about 29% of the sites on these districts have recorded impacts from roads.

9.3.5. Social

9.3.5.1. Introduction

While the natural and heritage resources managed by the Agency are generally well studied and inventoried, those attributes of forest management that fall into the realm of values and culture are less well known and are not easily accessible for the purpose of this analysis. Fortunately there are a myriad of methodologies and a wealth of social scientists available to help this Forest develop a database that would provide better information for local analyses when decisions are ripe at the appropriate scale.

The Issues and Key Questions identified for this aspect of the analysis suggest information crucial to informed decision-making. However, attempting to address them at this level and in this timeframe, when decisions are not ripe and citizens are not involved, is both frustrating and fruitless.

The Interdisciplinary Team has been able to bring natural resource data to the analysis describing physical conditions across the landscape. Unfortunately, our GIS system contains no equivalent in terms of social conditions.

9.3.5.2. Results and Interpretation

A careful review of *Analysis of Public Comments: Final Scoping Report (Proposed Rulemaking of Administration of the Forest Development Transportation System)* revealed five common and important themes which have resonance locally:

- Good decisions can only come from the local level with strong involvement by the public.
- The Agency is subject to too much external influence. (Perception of that influence varied widely.)
- "Wilderness" areas and "roadless" areas are one and the same in the minds of many. These are perceived to be very, very special places.
- There is substantial opposition to closing roads (for a variety of reasons), especially "ghost" roads.
- For any given opinion or belief expressed by anyone, there will be an opinion or belief expressed that represents the exact opposite.

Given our ability to identify environmental "hotspots," it is unlikely that a strong argument opposing decommissioning, obliterating, stabilizing, or closing any roads that jeopardize water, fisheries, wildlife or public safety would surface. When site-specific decisions are needed due to potential environmental impacts, early and extensive involvement of communities of both place and interest will not only inform the decision maker, but can be used to ferret out information unavailable to this analysis.

9.3.6. Lands

9.3.6.1. Introduction

The Willamette National Forest has many private inholdings, both large blocks of single owner "checkerboard" land ownership patterns and smaller, scattered ownership of a residential or small woodlot nature. Over time, there have been 12 major transportation system cost-sharing areas of some kind on the Forest. Of these, eight areas are still in operation on Sweet Home and Detroit Ranger Districts.

Although the cost-sharing mechanism for the remaining four areas have ended, the reciprocally granted, perpetual easements are still in place. The Forest does not have an exact count of these easements, but would *roughly* estimate 200. While the source documents for right-of-way grants to private parties are kept in the Forest's files, no compilation of these documents has been undertaken, either by computerized database or mapping.

9.3.6.2. Results and Interpretation

Unilateral action by the Forest Service on roads to which other parties have rights is rare. In cost-share areas, it requires Washington Office oversight. In almost all cases, easements granted to private parties have some type of due process provision for the private party included in the termination clause. Consequently, closing a road under easement or terminating that easement, and thereby terminating the private party's legal rights to the road,

is complicated. The same is true for relocation or reconstruction of roads under easement. An additional factor for shared roads is the cost the private party has assumed for construction of these roads.

9.3.7. Roadless Values

Roadless areas are undeveloped lands on the Forest that have no improved roads. Areas in an unroaded condition have been inventoried on the Forest at least three times: as part of the National Roadless Area Review and Evaluation (1973), the National Roadless Area Review and Evaluation (1979), and during the National Forest Management Act, Forest Plan development (1984-1989).

In recent years, the issue of unroaded lands on National Forests has become greater and more diverse than simply identifying the potential for inclusion in the National Wilderness Preservation System. In a broad sense, there is a diversity of values regarding roadless areas and these values often conflict. As the total amount of roadless area not included in the wilderness system continues to decline on the Forest, there is increased interest in the value of smaller unroaded areas.

9.3.7.1. Results and Interpretation

The primary issue of unroaded areas in this analysis is the amount and location of unroaded areas on the Forest stratified by size of area and Forest Plan land allocation. The key question is: *Where are the significant aquatic, terrestrial wildlife or ecological values associated with unroaded areas?*

Inventoried roadless areas mapped in 1984, total 210,509 acres. Of these, the area still roadless in 1998 is 112,166 acres. When the original area of 210,509 acres was overlaid with current Forest Plan land allocations, 45,164 acres (about 21%) were in land allocations allowing timber harvest. The remaining 165,345 acres (about 79%) are in land allocations that do not allow programmed timber harvest.

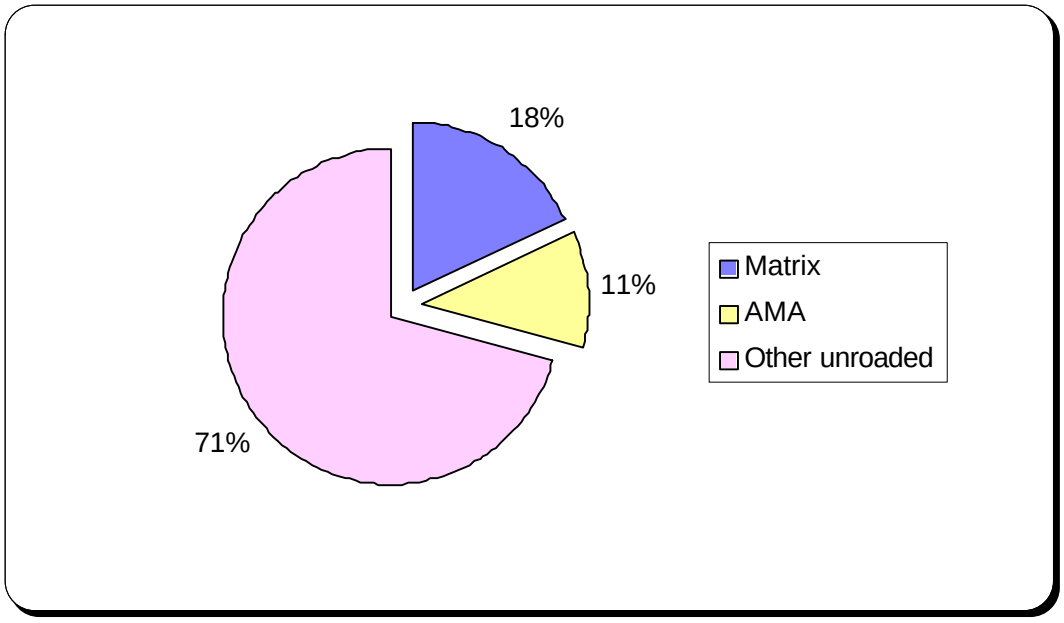
The moving window analysis of unroaded areas resulted in a total of 303,579 acres identified as unroaded and not harvested within the past 40 years and greater than 1,000 acres.

After screening, the total unroaded land area is broken down as follows (*see Figure 4):*

- ✓ 55,062 acres in matrix (timber harvest allowed)
- ✓ 33,237 acres in Adaptive Management Areas (AMA)
- ✓ 215,280 acres in remaining unroaded areas greater than 1,000 acres, in land allocations that preclude programmed timber harvest and where no future needs for additional road access are identified.

Our recommendation is to continue refinement of the unroaded map at the watershed level, identifying areas of significant ecological values and where they overlap with unroaded areas.

Figure 4. Total Unroaded Lands on the Forest



10. Options and Priorities

After reviewing and discussing the results of the analysis of Issues and Key Questions, the Willamette Road Analysis Team arrived at the following conclusions:

- Economics alone, financial efficiency, does not support large-scale road closures or decommissioning in spite of the current imbalance in funding available for forest roads. Road decommissioning is a capital investment, just as road construction was, and decisions regarding these investments must be based on a sound analysis of resource values. This highlights the importance of prioritizing areas for further transportation system decisions based on ecological and social factors.
- The analysis shows that access for recreation, fire suppression, vegetation management (including timber harvest), and other administrative uses is adequate and not likely to be a significant concern except on a site-specific or individual road basis. Access issues for these management needs are best addressed at a smaller, more site-specific scale. They are not a driver in this Forest level road analysis.
- Resource issues such as fish, wildlife, water quality, and other ecological values are the drivers that identify Forest level priorities for further transportation system analysis and decision making.
- As shown by the aquatics and wildlife analyses, roads create many types of potential hazards that can be displayed spatially and analyzed quantitatively in a variety of ways. Even the limited number of potential hazards identified in this assessment, when overlaid spatially, indicate that some type of hazard exists wherever there is a road.
- Resource values were overlaid with hazards (fish habitat, wildlife habitat, T&E habitats of both fish and wildlife, Forest Plan objectives, municipal watersheds) to identify where the hazards create risks of adverse impacts on resource values and identify "priority" areas. The result was similar; because of the large number of values identified, risks were nearly as ubiquitous as the hazards.
- In order to meet one of the original objectives of the assessment (to identify relative priorities and options for the transportation system), the team subjectively narrowed the list of hazards (quaternary landslides and road densities > 6 mi/mi^2 in mid-slope and valley bottoms) and resource values (T&E fish, impacts on Late Successional Reserves and high emphasis big game areas). These were then overlaid to identify sixth field subwatersheds where multiple hazards and values exist. The results are displayed on the Subwatersheds of Concern map and in Table 8 and Table 9.
- **All** of the hazards and **all** of the resource values and access needs, however, will have to be considered for the analysis that will result in decisions implementing changes in road access and transportation system management (*e.g.*, determining which roads will be decommissioned or managed at a different maintenance level).
- The current Forest policy to maintain access provided by the current arterial and collector road system may need to be revisited in the mapped Late Successional Reserves. Roads in these areas were built to a standard (including maintenance standard) based on compliance

with significantly different land management objectives. The current land management objectives may be achievable with a different standard of road or less roads than previously assumed.

- Only a handful of unroaded areas are in land allocations or parts of the Forest where additional road access is needed to implement current Forest Plan direction. About 79% of the inventoried roadless areas and 78% of the unroaded areas >1000 acres are in land allocations that preclude timber harvest.
- A significant component lacking in the integration of results was information on the social aspects of the transportation system. The Social Process Paper (Appendix J) details the difficulties in addressing the social Issues and Key Questions and identifies opportunities and available measures to address information deficiencies. The road analysis team endorses the need for community collaboration at all levels of forest road assessment and analysis, particularly where decisions to change or modify the current level of access are anticipated (subwatershed or project level). Collaborative efforts go beyond simple public information and require a significant investment of time and agency resources. Therefore, areas should be prioritized based on social values for different levels of collaboration during forest road analysis, just as areas have been prioritized in this assessment based on ecological values.
- Related to the above conclusion, is the team's observation that a majority of individual concerns about roads relate to specific roads and locations on the Forest. This is based on comments received on the National Roads Policy and past comments on the Forest Plan. Interest in assessments to establish priorities and process for further decision making at the Forest level was limited to regional and national interest group representatives with an interest in influencing regional and national policy on forest roads.
- Another significant information gap vital to the forest road analysis is the lack of information at the forest scale on the number and location of roads for which the Forest has entered into easements and cost-share agreements with private parties. This is significant, because the Forest can not unilaterally make decisions about managing these roads.

10.1. Identifying Subwatersheds of Concern

The sixth field subwatersheds rated as Very high, High, Moderate and Low-moderate in Table 7.1 were identified based on an interdisciplinary determination of key resource hazards and resource values. As previously mentioned, the hazards and values were narrowed to provide differentiation or relative levels of priorities among the Forest subwatersheds.

To establish different levels of concern, the resource values and resource hazards were assigned numerical values as follows:

- Quaternary landslides - Present in subwatershed = 1; Not present in subwatershed = 0.
- Road densities greater than 6 miles/mile^2 on midslopes or in valley bottoms - Present in subwatershed = 1; Not present = 0.

- Fisheries - Occupied T&E (or formally proposed T&E) habitat = 2; Historical T&E habitat = 1; Not present = 0.
- Big Game (High emphasis areas only) - Open road densities exceeds Forest Plan objectives by more than 1 mile/mile^2 = 2; Open road densities exceeds Forest Plan objective by less than 1 mile/mile^2 = 1.
- Late successional connectivity (within Late Successional Reserves only) - High impact to connectivity = 2; moderate impacts to connectivity = 1.

Subwatershed scores of 6 or greater were ranked as Very high level of concern; scores of 5 were High; scores of 4 were Moderate and scores of 3 were Low-moderate.

Quaternary landslides were selected as one of the hazards for evaluation because these geologic features are best analyzed at a landscape scale and are features that can produce significant amounts of fine sediment due to presence of forest roads, especially at mid-slope and valley bottom positions. Road densities greater than six miles/mile^2 in mid-slope and valley bottoms were the other hazard chosen by the team for inclusion in the evaluation. Road densities of this level have been identified by both fish and wildlife biologists in consultations for threatened and endangered species, as having significant adverse impacts on habitat and populations. Also, this road density on mid-slopes and valley bottoms has been associated with increases in peak flows in some studies and the subsequent impacts on stream channels and fish habitat.

The resource values chosen were based on meeting legal requirements of the Endangered Species Act and impacts due to forest roads above current Forest Plan objectives. Occupied or historic Threatened and Endangered fish habitat was the first concern identified, since it has implications for meeting legal requirements of the Endangered Species Act. The other two resource values, big game habitat and late successional habitat, were identified in those areas where analysis indicated that road impacts significantly exceeded Forest Plan objectives.

It is obvious that including different hazards, resource values or assignment of values would change the identification of subwatersheds of concern or their ranking. The team considered adding municipal watersheds as a resource value in the exercise, since there was agreement that municipal water supplies are a significant resource value. However, when the team evaluated how the results would change, adding municipal watersheds resulted in only minor changes in the relative ranking of the subwatersheds and an additional 12-15 subwatersheds identified as Moderate or Low-moderate concern. This is just one example of how different hazards and resource values could affect prioritization.

The road analysis team recognizes that the subjectivity mentioned above could raise questions about the overall value and creditability of the assessment and has three points in response.

1. The prioritization of the subwatersheds in Table 7.1 is only one product or outcome of the forest road assessment. While it provides Forest managers with interdisciplinary input to determine where to focus follow-up access and travel management efforts, it is not the only useful product of this assessment. The other tools and analysis summarized in Section 6 and detailed in the Process Papers (Appendices A-M) will improve the efficiency and consistency of ATM and access decisions at the watershed and project level.

2. This is ***NOT*** a decision making process; final decisions to decommission, maintain, or construct forest roads are not being made or directed by this assessment. Other resource values and hazards caused by roads will be considered in local context and with public involvement and review before decisions are made to change the current level of forest access.
3. This assessment is only one source of information and input to future decisions regarding Forest roads and access. As illustrated in Figure 5, managers have several sources of information to consider during the decision-making process for forest roads. While it may be desirable to incorporate all of these sources of information into one grand analysis, it is not a realistic or feasible expectation.

Figure 5. Analysis, Options, Decisions

Table 8 Results of evaluating overlap of significant hazards and resource concerns. Sixth field watersheds ranked in the order of most hazards and resource concern overlaps.

Watershed and 6th field no.	Level of Concern	Quaternary Landslides present.	Road Density >6 mi/sq. mile	Fish Status	Exceeds high emphasis big game objectives	Late Succession Connectivity impacts in LSRs	Other resource concerns
Hills Creek 22 1	Very High	Y	Y	Historic & T&E occupied.	Y < 1 mi/sq. mi.	Y High impact	Road density in riparian reserves > 6 mi/sq mi. Affected special habitats >75%
Lookout Res 19 1	Very High	Y		T&E occupied (OR chub)	Y > 1 mi/sq. mi.	Y Moderate impact	Key Watershed for O. Chub Affected special habitats >85%
S. Santiam 06 1	High		Y	T&E occupied	Y < 1 mi/sq. mi.	Y Moderate impact	Municipal Watershed
UMF Wil 21 3	High	Y		T&E occupied	Y > 1 mi/sq. mi.		
UMF Wil 23 4	High	Y	Y	T&E occupied	Y < 1 mi/sq. mi.		Road density in riparian reserves > 6 mi/sq. mi.
UMF Wil 23 6	High	Y	Y	T&E occupied	Y < 1 mi/sq. mi.		
UMcKenzie 07 7	High		Y	T&E occupied	Y > 1 mi/sq. mi.		Key Watershed Municipal Watershed
S. Santiam 06 7	High	Y		T&E occupied	Y < 1 mi/sq. mi.	Y Moderate impact	Municipal Watershed
UMcKenzie 07 3	Moderate		Y	T&E occupied	Y < 1 mi/sq. mi.		Key Watershed Municipal Watershed
UN Santiam 78 4	Moderate	Y	Y	Historic T&E	Y > 1 mi/sq. mi.		Municipal Watershed
UN Santiam 78 6	Moderate	Y	Y	Historic T&E	Y < 1 mi/sq. mi.	Y Moderate impact	Key Watershed Municipal Watershed

Watershed and 6th field no.	Level of Concern	Quaternary Landslides present.	Road Density >6 mi/sq. mile	Fish Status	Exceeds high emphasis big game objectives	Late Succession Connectivity impacts in LSRs	Other resource concerns
UN Santiam 79 2	Moderate		Y	Historic T&E	Y < 1 mi/sq. mi.	Y Moderate impact	Key Watershed Municipal Watershed
Horse Cr. 14 1	Moderate	Y		T&E occupied		Y Moderate impact	Key Watershed Municipal Watershed
Salmon Cr. 18 1	Moderate	Y	Y	Historic T&E		Y Moderate impact	
S. Santiam 06 3	Moderate			T&E occupied	Y > 1 mi/sq. mi.		Municipal Watershed
N. Santiam 78 3	Moderate-Low	Y		Historic T&E	Y > 1 mi/sq. mi.		Municipal Watershed
Breitenbush 92 2	Moderate-Low	Y	y	Historic			Municipal Watershed
Mid Santiam 05 4	Moderate-Low	Y			Y < 1 mi/sq. mi.	Y Moderate impact	
S. Santiam 06 9	Moderate-Low		Y	T&E occupied			Municipal Watershed
Mck Tribs 11 1	Moderate-Low	Y		T&E occupied			Municipal Watershed
Fall Creek 15 1	Moderate-Low	Y		Historic	Y < 1 mi/sq. mi.	Y Moderate impact	
Fall Creek 15 2	Moderate-Low	Y		Historic		Y Moderate impact	
Fall Creek 15 3	Moderate Low			Historic		Y High impact	
Fall Creek 15 5	Moderate-Low			Historic		Y High impact	

Watershed and 6th field no.	Level of Concern	Quaternary Landslides present.	Road Density >6 mi/sq. mile	Fish Status	Exceeds high emphasis big game objectives	Late Succession Connectivity impacts in LSRs	Other resource concerns
Salt Creek 21 2	Moderate-Low	Y				Y High impact	
UN Santiam 79 3	Moderate-Low	Y	Y	Historic			
UMF Will 23 5	Moderate-Low	Y		T&E occupied			
SFMcKenzie 13 5	Moderate-Low		Y	T&E occupied			Municipal Watershed
SFMcKenzie 13 9	Moderate-Low	Y		T&E occupied			Municipal Watershed
U McKenzie 07 1	Moderate-Low			T&E occupied	Y < 1 mi/sq. mi.		Municipal Watershed
S. Santiam 06 6	Moderate-Low	Y			Y < 1 mi/sq. mi.	Y High impact	Municipal Watershed

Fish - Historic habitat denotes areas now blocked by dams that were once occupied by either winter steelhead, spring chinook or bull trout.

Quaternary Landslides - These are large, deep-seated, slow moving earthflows that move in a slow, episodic manner. They are of a recent geologic era (10,000 years to present).

Table 9. Other Resource Access considerations in Subwatersheds of Concern.

Watershed and 6th field no.	Recreation Issues	Historic Routes	Fire Level of human caused fires	Trails	Commodities Acres of "unaccessed matrix"	Other Area in LSR allocation
Hills Creek 22 1			low	1 trailhead	91 acres	In LSR 221
Lookout Res 19 1		Oregon and Eastern Railroad	high	12 trailheads	256 acres	In LSR 222
S.Santiam 06 1	Eligible W&SR	Santiam Wagon Road (SWR)	low	4 trailheads	2 acres	In LSR 215
UMF Wil 21 3		Oregon Central Military Wagon Road (OCMWR)	high	1 trailhead	325 acres	In LSR 222
UMF Wil 23 4	Eligible W&SR	OCMWR	moderate	3 trailheads	274 acres	
UMF Wil 23 6	Eligible W&SR	OCMWR	moderate		426 acres	
UMcKenzie 07 7		Old McKenzie Hwy	very high		243 acres	
S.Santiam 06 7	Eligible W&SR	SWR	low		23 acres	In LSR 215
UMcKenzie 07 3	W&SR	Old McKenzie Hwy	very high	2 trailheads	648 acres	
UN Santiam 78 4			high		82 acres	
UN Santiam 78 6	Eligible W&SR	Hogg Railroad	high		106 acres	In LSR 214
UN Santiam 79 2	Eligible W&SR	Hogg Railroad	very high		12 acres	In LSR 214
Horse Creek 14 1			low		105 acres	In LSR 218
Salmon Cr. 18 1			moderate		484 acres	
S.Santiam 06 3			low		14 acres	
N.Santiam 78 3			high		0 acres	In LSR 213
Breitenbush 92 2	Eligible W&SR		moderate		361 acres	

Watershed and 6th field no.	Recreation Issues	Historic Routes	Fire Level of human caused fires	Trails	Commodities Acres of "unaccessed matrix"	Other Area in LSR allocation
Mid Santiam 05 4			low	3 trailheads	4 acres	In LSR 213
S.Santiam 06 9			low		2112 acres	
Mck Tribs 11 1			low		48 acres	In LSR 217
Fall Creek 15 1			moderate		4 acres	In LSR 219
Fall Creek 15 2			moderate		42 acres	In LSR 219
Fall Creek 15 3			moderate		0 acres	In LSR 219
Fall Creek 15 5			moderate		0 acres	In LSR 219
Salt Creek 21 2		OCMWR	high		396 acres	
UN Santiam 79 3	Eligible W&SR	Hogg Railroad	very high		448 acres	
SFMcKenzie 13 5			moderate			
SF McKenzie 13 9	Eligible W&SR		moderate			
UMcKenzie 07 1			very high			
S.Santiam 06 6		SWR	low			In LSR 215

Wild and Scenic River- Watersheds containing river segments identified as eligible for W&SR designation in the Forest Plan or those currently designated as W&S are identified. The assumption is that a reduction of the miles of road with the potential or existing W&SR boundary could be beneficial to the attributes that distinguish the river segment as wild and scenic. Environmental issues (sedimentation, fish habitat, vegetation loss) and social issues (overcrowding, litter, sanitation) could be addressed through road management decisions in these areas.

Fire - Very High > 150 fires in 25 year period; High > 90 fires; Moderate >40 fires; Low < 39 fires. Based on the analysis presented in the fire process paper the assumed relationship is that decreased road densities MAY reduce the incidence of human caused fires. Therefore reducing open road densities in those watersheds with very high and high incidences of human caused fires could be beneficial. The issue of access for fire suppression is not addressed in this matrix, however, in areas with existing high road densities, reductions in the miles of maintenance level 1 and 2 forest roads may not significantly impact fire suppression access. Site specific assessment is required to fully address these issues, however.

Other - LSRs - Within the portion of the sixth-field watershed that is in LSR there may be opportunities to reduce not only the amount of Maintenance Level 1 and 2 roads (local roads) there may also be an opportunity to consider changing management on entire collector road systems within the LSR either by reducing the amount of the collector roads or lowering the maintenance levels to a 1 or a 2 to reflect the changed use of the road in the LSR allocation.

III. PROCESS CRITIQUE

There were two primary purposes driving this forest road assessment. The first was to complete a Forest level assessment of Forest roads and access-related issues on the Willamette National Forest. The other was to test the draft road analysis process developed by the Washington Office Road Analysis Team and to provide comment and feedback to the team on that process. The Willamette Forest Road Analysis Team recognized the dual purposes of this assessment from the beginning, and, early in the assessment, discussed possible ways of evaluating the Draft Road Analysis throughout the two-month process. Many of the resource specialists included a summary process critique at the end of their process papers. Following is the team's combined critique and feedback.

The Six-Step Process

In general, the team felt that the six-step process outlined in the draft analysis process document was useful. While it basically describes a generic, resource planning/assessment process used in many different contexts throughout the agency, the team felt that it was useful to describe the process specifically in the context of a road analysis. One team member related a recent experience on an interdisciplinary team working on an Access and Travel Management Plan at the watershed level and suggested that had they used the six steps as a model it could have eliminated or reduced much confusion or "wheel spinning" early in their analysis. The only caveat the team suggests for the six-step process is that it remain a guide or model for forest road analysis and not a prescription as the only planning model for forest road analysis.

Data

This is a common topic in the critique of any analysis or planning process. The team's comments on data in relationship to this assessment can be summarized in five categories.

- **Accuracy**: This was a major concern with the Forest transportation layer in this analysis for obvious reasons. Some of the team members had experience with project level analyses, where more roads actually existed on the ground than were shown in the transportation GIS layer. In other cases, reviews by District Rangers indicated that not all existing road closures were updated in the database. Because this layer was crucial to many of the resource analyses for this assessment, the transportation planner on the team compared the road information on the Forest transportation layer to at least two areas where roads had been intensively surveyed and field verified. Based on these comparisons, he developed an estimate of the potential error in the transportation layer. This was very useful in helping other team members to make an objective evaluation of the road data and determine if or how the potential differences between the database and actual road miles would affect the results or interpretation of the analysis.
- **Consistency**: Some of the data layers used in these resource analyses were obviously mapped at different levels of intensity across the Forest. The best example is the Forest stream GIS layer. While there is a Forestwide stream coverage, due to different levels of mapping at watershed or Ranger District levels or different mapping techniques, the number of streams displayed varied, especially for intermittent streams. The ideal is to

have consistent mapping across the entire area analyzed, in this case the Forest. However, at a minimum, resource specialists conducting the analysis and managers using the results should be aware of differences within a single data layer and factor this into any interpretation of the results.

- **Different Scales of Data** This was another concern and has to be recognized in any kind of analysis. In an effort to provide data coverage for the entire Forest, data gathered at different scales and different levels of detail was used. This is similar to the above issue about consistency of mapping or data available.
- **Availability**: It was readily obvious that data simply did not exist to address some of the Issues and Key Questions. The best example of this was in response to the social issues and questions. As noted in some detail in the Social Process Paper (Appendix J), some of the basic baseline social data and information does not exist. Other resource examples are stream surveys to address the fisheries issues and questions. The team's best advice is to highlight the gaps in data availability as soon as possible in the process and consider alternative means of addressing the issues and questions.
- **Format**: In some cases, information or data to address or answer the issues and key questions existed, but it was not in a format easily or readily accessible at the Forest level. At times, this was not a significant deterrent to the assessment because it was determined that the issue or question was most appropriately addressed at a smaller scale (watershed or project) and the data would be usable at that scale. An example was the information on archeological sites and how they have been impacted by roads.

  However, in other cases, the lack of information or data in a format that could be readily analyzed at the Forest scale did detract from the assessment. The best example was the road easement and cost-share information. Knowing the location and nature of these agreements would have been useful information to overlay with other resource information to get a better idea of future workload and potential complexity of further road analyses in specific watersheds or subwatersheds.

Timeframe

The Willamette NF Road Analysis was completed in approximately 10 weeks beginning in late August and ending in mid October. Although Forest managers knew about the pilot road analysis in early August, the team did not get fully organized and operational until late August. Since it was the type of project that, in the best of situations, displaced or postponed existing work and, in the worst case, added to existing workloads, most of the team felt pressured by the timeframe given for the analysis. Most of the team adopted the approach that the timeframe was fixed and adjusted the level or intensity of their analyses to fit the time available. This also required prioritizing the analyses most meaningful to the results and the desired product (perhaps a beneficial outcome of the short timeframe).

The team suggests that in similar situations managers and supervisors allow team members "focused time" to work on assessments to the extent possible. Even within compressed timeframes, team members who were able to devote blocks of time to the analysis felt better about the assessment process than team members who had to continue to cover other program

responsibilities and projects. Those with focused time were also better able to interact with each other in an interdisciplinary manner.

Public Involvement

Due to the compressed timeframe for the pilot assessment, the team and line officers understood and agreed up-front that there would not be any public involvement or collaboration. The team's reaction to this lack of public involvement and participation was mixed. The concern was that it is a missed opportunity and will subject the assessment to criticism that it is inaccurate or inadequate simply due to the lack of opportunity for public input. On the other hand, given the scale of the assessment and the determination that many public use issues are site-specific and thus most appropriately addressed at a smaller scale, it wasn't clear what kind of public input could have been solicited and how it would have affected the analysis.

First, the team recommends that future assessments allow time necessary for public involvement and collaboration. However, the type of involvement and collaboration will vary depending on the scale of the road assessment (Forestwide versus subwatershed) and the degree of public interest in a particular area. Secondly, the type and level of public involvement should be commensurate with the scale and expected products/outcomes. In other words, if it is an assessment to prioritize where site-specific analysis should be done, it is important that the public knows the objective, and understands that concerns about access to particular areas will be addressed at a different scale in a separate process.

Internal Review

Due to the compressed timeframe, this pilot Forest Road Analysis was undertaken by an interdisciplinary team of Forest resource specialists in the Forest Supervisor's Office and the analysis results were not available for review by the District Rangers prior to producing the assessment report. Thus, the likelihood of errors in the assessment was increased, in large part due to database inconsistency and quality problems previously mentioned. The lack of internal review also prevented field verification of criteria and rating procedures, which in the long run undermines the utility of the assessment. The team suggests that while the initial report is reviewed by the National Road Analysis Team, the report and analysis results should also be thoroughly reviewed by the Districts. Then the Forest road team should be reconvened for the time necessary to make any needed adjustments or corrections identified in the review.

Definitions

Early in the assessment process the team realized that they did not have a common understanding of forest road terminology. This created a significant distraction when attempting to identify and discuss the issues. As a result, the Glossary was the first section of the report written. This lack of common understanding and use of road terminology is likely to increase exponentially with extensive public involvement. Due to the variety of terms used to describe and define forest roads, conditions, treatments, and closures, the team strongly suggests that the National Road Analysis emphasize the use of standard definitions.

Issues and Key Questions

Due to the compressed timeframe, the team used the list of Issues and Key Questions in the Appendices of the Draft Road Analysis Procedure as the basis for identifying issues and key questions for the Willamette Forest Pilot Road Analysis. Going into the process somewhat "cold" and with a definite sense of urgency to move forward, some of the team members felt that they didn't have enough time to adequately assess the appropriateness or value of the suggested issues and key questions. Although team members felt that all of the suggestions in the Appendices raised legitimate Forest road and road access issues, they began to feel that not all of them were necessarily pertinent or important at the Forest scale of analysis. The team's suggestion is to de-emphasize the use of standard issues and key questions in the National Road Analysis Procedure, and perhaps replace them with a list of possible resource concerns.

Scale

Scale was an important consideration throughout this road analysis. Beginning with the development of issues and key questions and continuing through the process paper documentation, the team continually evaluated and debated the appropriateness of the scale for addressing different issues and questions. The conclusion is that different scales of road analyses and assessments have their own strengths and weaknesses. The Forest scale of road analysis provides a strong basis for dealing with programmatic issues such as road impacts on fish and wildlife--especially T&E species where the analysis provides useful information for consultation and recovery strategies. It also provides a means of determining areas with numerous hazards due to inherent soil conditions, geologic features, stream densities, and their intersection with the existing road system. The Forest scale is also the most appropriate level for identifying unroaded areas and evaluating landscape strategies for these areas.

On the other hand, the Forest scale analysis is limited in its ability to identify road use and road user issues, such as dispersed recreation use, access for management needs and fire suppression. It is also difficult to identify or prescribe treatments for site-specific road hazards such as culverts, local areas of instability and other road failures. The team appreciates the wide variety of conditions and situations among the National Forests and the possibility that, in some cases, the issues of scale may not be as pronounced as they are in Western Oregon. However, in most cases, it may be beneficial to recognize that the most efficient road analysis should be undertaken at multiple scales. In the case of the Willamette NF, the team feels that the Forest Road Assessment provides priorities, options, analysis tools, and sets the context for road analysis (Access and Travel Management) at a smaller scale such as the watershed or subwatershed level.

Other Assessments

The Willamette NF (and other National Forests in the area of the Northwest Forest Plan) have completed watershed analyses following a prescribed process with some similarities to the Draft Road Analysis Procedure. In addition, assessments have been completed on the Late Successional Reserves created by the Northwest Forest Plan. Although neither the watershed analyses nor the LSR assessments focused on roads, both roads and their impacts on other resources were analyzed and explored in these assessments. The team looked at these other assessments during this road analysis and developed a summary of all the recommendations from the watershed analyses pertaining to forest roads and road access. Findings and analyses

from the LSR assessments were incorporated into the terrestrial wildlife analysis. The team suspects that the Willamette and the other Northwest Forest Plan Forests are not unique by having a variety of other landscape assessments and analyses completed in the past two to five years that have analyzed forest roads and their impacts. The team recommends that the national team consider options to integrate the required road analysis with other landscape or watershed scale assessment processes already in place. This may enhance the overall efficiency of the analyses.

12.

13. Team Members and Contributors

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14. Contributors

Completion of this report involved many people, far too numerous to list here. Many of these contributors provided their time and expertise from the Forest, Ranger Districts, Regional Office, and Washington Office Road Analysis Team.

15.

16. GLOSSARY

Access and Travel Management (ATM) - A design and implementation of objectives, strategies, prescriptions, and operation plans for providing access and travel opportunities in the forest. It is not a new idea or process. ATM considers and coordinates all resource needs, user groups, modes of travel, economic and legal issues, traffic and safety requirements, and agrees with both National and Regional policy using the Forest's ATM Guide in conjunction with the Forest Land & Resource Management Plan as a guiding document. ATM is dynamic, for it constantly responds to changing public, economic, land and resource management needs.

All-Terrain Vehicle (ATV) - A vehicle able to negotiate most kinds of terrain through traction devices such as wide tracts, large low-pressure rubber tires, and/or four-wheel drive *(see ORV).*

Anthropogenic - factors related to human influences or effects

Archaeological sites - typically the material remains of ancient native inhabitants, but can also be historic sites.

Arterial Roads - Primary travel routes that provide service to a large land area. They usually connect with public highways, or other Forest Service arterial roads.

Big Game Emphasis Area (BGEA) – Mapped areas with specific management objectives delineated in the Willamette National Forest Plan (1990) consisting of one to several subwatersheds and ranging from 1,000 to 15,000 acres. Each emphasis area has been assigned a rating of high, moderate or low and may overlap one to several management areas.

Benefit/cost ratio - A measure of economic efficiency computed by dividing total discounted primary benefits by total discounted economic costs

Closed Travelway (Road) - A road on which all vehicle traffic has been excluded by natural blockage, barricade, regulation, or by obscuring the entrance. A closed travelway is still an operating facility on which traffic has been removed (year-long or seasonal) and remains on the Forest Development transportation system. Closed travelways have two general categories: regulated use and restricted use.

Regulated Use (Gated Roads)

"Seasonally Open": These roads are closed part of the year to publics with a gate, sign or other device for purposes of wildlife management, recreation use or other resource management reasons. While some may be maintained for passenger cars, most of these roads are maintained for high-clearance vehicle use. In those cases where resource management or access and travel plans have identified an administrative need, such as user conflicts, safety hazards, fire control or special use access, the road will still be maintained, but closed with a gate or other removable device. Prohibited use signs will be posted on these devices.

Restricted Use

"Closing Naturally": These roads serve no identified access need, and are not causing resource damage. Therefore, they do not require immediate closure with some sort of device. Closure will occur gradually. The road will first be stabilized; however, brush will not be cut or slumps and rockfall removed unless resource

damage is occurring. The lack of maintenance will eventually result in the road becoming impassible to motor vehicles.

"Closed With A Device": These roads are closed to all designated traffic year-round, but will remain on the road system for potential use in the future. Access is controlled by permanent devices or a natural barricade. Prohibited and allowed uses are signed. These roads will also be stabilized.

Code of Federal Regulations (CFR) - Contains traffic management and traffic engineering requirements that the Forest Service must follow in the management and operation of national forest roads *(see "Regulated Use").*

Collector Roads - Roads that serve small land areas and usually connect with National Forest arterial roads or public highways. They collect traffic from local roads and terminal facilities.

Cooperative Work Forest Service (CWFS) Funds – The acceptance of contributions for deposit in the US treasury, available for expenditure by the Forest Service for road maintenance.

Cultural properties - locations of traditional cultural activities of indigenous people and their descendants.

Decommissioned Road - To remove those elements of a road that reroute hill slope drainage and present slope stability hazards. The road is stabilized to reduce potential for storm damage and the need for maintenance. The road's travelway is no longer suitable for travel. Decommissioning includes putting a road in storage (storm proofing with dips, berms, waterbars etc) for later use, or in some cases the road is obliterated (restoring the hydrologic function of the ground by decompacting the road surface, removing fills and culverts, re-vegetating etc) to never be used again.

Developed Recreation - Recreation that requires facilities, resulting in concentrated use of an area. An example of a developed recreation site is a campground. Facilities might include roads, parking lots, picnic tables, toilets, drinking water, and buildings.

Drainage - In this document, drainage refers to a culvert, which is a conduit or passageway under a road, trail or other facility.

Dispersed Recreation - A general term referring to recreation use outside developed recreation sites. This includes activities such as scenic driving, hiking, bicycling, backpacking, hunting, fishing, snowmobiling, horseback riding, cross-country skiing, and recreation in primitive environments.

District - (Ranger District). A geographic administrative subunit of the Forest.

Ecosystem - A complete, interacting system of organisms considered together with their environment--*e.g.*, a marsh, a segment of a stream, or a lake.

Ecosystem Management - Using an ecological approach to achieve the multiple-use management of National Forests and Grasslands by blending the needs of people and environmental values in such a way that National Forests and Grasslands represent diverse, healthy, productive, and sustainable ecosystems.

Environmental Assessment (EA) - A systematic analysis of site-specific activities used to determine whether such activities have a significant effect on the quality of the human environment and whether a formal environmental impact statement is required; and to aid an

agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary.

Emergency Relief for Federally Owned Roads (ERFO) – ERFO funds to repair catastrophic failure of federally owned roads. This does not include failures resulting from structural deficiencies or normal physical deterioration.

> **ERFO Funds** – Emergency relief funds available for expenditure under the authority of 23 U.S.C. 125(a) and (c).
>
> **ERFO Projects** – Projects funded partially or entirely with ERFO funds.

External Benefits - a positive impact caused by the agency benefiting some other party without requesting payment, such as enhanced property values.

External Costs - cost is one caused by the agency and imposed on some other party without compensation, such as polluting water, or degrading scenic beauty. In this same token external benefits such as enhanced property values were also not investigated.

Federal Highway Administration (FHWA) - The federal public road authority responsible for federal highways to be open to pubic travel and commerce.

Financial Efficiency - The usefulness of costs to produce outputs. In measuring financial efficiency, costs are limited to those that can be valued in an open market.

Forest Ecosystem Management Assessment Team (FEMAT) - A team that developed a report titled "Forest Ecosystem: An Ecological, Economic and Social Assessment" commonly referred to as "the FEMAT Report." The FEMAT is Appendix A of the Final Environmental Impact Statement (FEIS), on Management for Late- Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl.

Forage - All browse and non-woody plants harvested for feed or available to livestock or wildlife for grazing.

Forest Plan - The Willamette's Land and Resource Management Plan which "...provide(s) for multiple use and sustained yield of goods and services from the National Forest System in a way that maximizes long-term net public benefits in an environmentally sound manner."

Forest Development Road - *See "Roads".*

Forest Service Manual (FSM) - A manual that provides a unified system for issuing, storing, and retrieving all continuing direction that governs Forest Service programs and activities. The manual sets forth legal authorities, management objectives, policies, responsibilities, delegations, standards, procedures and other instructions that are continuing and that apply to or are needed by more than one unit.

Guideline - A policy statement that is not a mandatory requirement (as opposed to a standard, which is mandatory).

Heritage Resource - Any definite location of past human activity identifiable through field survey, historical documentation or oral evidence. This includes archaeological and architectural sites or structures, and places of traditional cultural or religious importance to specified groups whether or not represented by physical remains.

Highway Safety Act of 1966 (P.L. 89-564) - Directs states and participating agencies to identify and survey accident locations; to design, construct, and maintain roads in accordance

with safety standards; to apply sound traffic control principles and standards; and promote pedestrian safety. This Act applies to forest roads that have operation and maintenance levels of "3" to "5" (roads suitable for passenger cars).

Hydrologic - Describing quantity, quality and timing of water yield.

Inholding - Land belonging to one landowner that exists within a block of land belonging to another. For example, small parcels of private land exist within national forest boundaries.

Interdisciplinary Team (IDT) - A group of individuals with varying areas of specialty assembled to solve a problem or perform a task. The team is assembled out of recognition that no one discipline is sufficiently broad enough to adequately analyze the problem and propose action.

Key Watershed - A term in the President's Forest Plan for a watershed containing (1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or (2) greater than six square miles with high-quality water and fish habitat.

Landing - Any place on or adjacent to a logging site where logs are assembled for further transport.

Long Term - In the context of these guidelines, 10 years and beyond.

Monitoring - The process of collecting information to evaluate if objectives and anticipated or assumed results of a management plan are being realized or if implementation is proceeding as planned.

Maintenance Levels - Defines the level of service provided by, and maintenance required for, a specific road, consistent with road management objectives and maintenance criteria:

> *Maintenance Level 1* - Assigned to intermittent service roads during the time they are closed to vehicular traffic. The closure period is one year or longer. Basic custodial maintenance is performed.
>
> *Maintenance Level 2* - Assigned to roads open for use by high clearance vehicles. Passenger car traffic is not a consideration.
>
> *Maintenance Level 3* - Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities.
>
> *Maintenance Level 4* - Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds.
>
> *Maintenance Level 5* - Assigned to roads that provide a high degree of user comfort and convenience. Normally, roads are double-lane and paved, or aggregate surfaced with dust abatement.

Management Area - For purposes of this guide, geographic areas designated or described by certain resource and land allocations contained in current Forest Plan and subsequent area or landscape plans.

National Environmental Policy Act (NEPA) of 1969 - An Act to declare a National policy which will encourage productive and enjoyable harmony between humans and the environment, to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, to enrich the understanding of the ecological

systems and natural resources important to the nation, and to establish a Council on Environmental Quality. (The Principal Laws Relating to Forest Service Activities, Agriculture Handbook No. 453, USD, Forest Service, 359 pp.)

National Forest Management Act (NFMA) - A law passed in 1976 as an amendment to the Forest and Rangeland Renewable Resources Planning Act, requiring the preparation of forest plans and the preparation of regulations to guide that development.

The National Fire Management Analysis System (NFMAS) - A formal process that provides a consistent and objective method for estimating the efficiency and effectiveness of alternative fire protection programs using an economic efficiency criterion.

Net Public Benefit - An expression used to signify the overall long-term value to the nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs) whether they can be quantitatively valued or not. Net public benefits are measured by both quantitative and qualitative criteria rather than a single measure or index.

Obliteration- Restoring the hydrologic function of the ground by decompacting the road surface, removing fills and culverts, re-vegetating, or other actions with the intent that the road will not be used again.

Off-Road Vehicle (ORV) - Any motorized track or wheeled vehicle designed for cross-country travel over natural terrain (*e.g.*, motorcycles, all-terrain vehicles, four-wheeled drive vehicles, and snowmobiles *(see also ATV)*).

Open Road Density - Roads receiving more than one round trip per month as per Memorandum of Understanding with Oregon Department of Fish and Wildlife.

Partnership - In the context of these guidelines, partnerships are those alliances between individuals, groups and/or the Forest that enable road and trail maintenance or monitoring activities beyond those required for resource management access. Partnerships: 1) Foster good stewardship within the land management plan; 2) Are not exclusive but serve publics at large; 3) Benefit all parties involved.

President's Forest Plan (4/94) - Option 9 of FEMAT. Alternative 9 and the preferred alternative of the DSEIS. Sometimes referred to as the Forest Plan, (not to be confused with the National Forest Management Act of 1976 (NFMA) definition of a Forest Plan).

Project - An organized effort to achieve an objective, identified by location, activities, outputs, effects, and time period and responsibilities for execution.

Public Involvement - A Forest Service process designed to broaden the information base upon which agency decisions are made by (1) informing the public about Forest Service activities, plans and decisions, and (2) encouraging public understanding about and participation in the planning processes leading to final decision making.

Quaternary Landflow – Large unstratified geological areas of slow-moving landflows. Primarily applied to basalt and andesite flows that overlie clayey tuffaceous rocks.

Recreation Opportunity Spectrum (ROS) - Land delineations that identify a variety of recreation experience opportunities. They are categorized into six classes: Primitive, Semi-primitive Nonmotorized, Semi-primitive Motorized, Roaded Natural, Rural, and Urban.

Restricted Use - Restricted use is a passive form of facility management relying on (1) voluntary user compliance with signs provided at or on the facility, or (2) commercial user

compliance with contractual requirements outlined therein.

Riparian Area - A geographic area containing an aquatic ecosystem and adjacent upland areas that directly affect it. This includes floodplains, woodlands, and all areas within a specified distance from the normal line of high water of a stream channel or from the shoreline of a standing body of water.

Road - A general term denoting a facility for purposes of travel by vehicles greater than 50 inches in width. Includes only the area occupied by the road surface and cut and fill slopes (FSM 2355.05). Types of roads include:

> *Forest Road*: A road wholly or partly within, or adjacent to, and serving the national forest system and which is necessary to protect, administer, and use the national forest system and its resources (23 USC 660.103).
>
> *Forest Development Road*: A "forest road" under the jurisdiction of the Forest Service (FSM 7705).
>
> *Forest Highway*: A forest road open to public travel, and under the jurisdiction and maintenance of a public road authority. The Forest Service is not a public road authority (23 USC 660.105).
>
> *Primary Road*: High standard through-routes, arterial linkages, Scenic Byways. These will handle the majority of Forest visitor and other travel needs. They will be maintained at levels that safely accommodate low-clearance vehicles (typically a passenger car).
>
> *Secondary Road*: Key inter-forest connections to interior recreation, forest management and fire response. These connect trailheads, project sites, special use areas, research areas, development sites, or private lands to the primary road network.
>
> *Temporary Road*: Roads associated with such uses as timber sale contracts, land and minerals needs or special use permits. These roads are not intended to be a part of the forest development transportation system and not necessary for future resource management (FSM 7705).
>
> *Non-System Travelway (Ghost Road)*: A road within the National Forest System that is not necessary to protect, administer, or use the national forest system or its resources. (An example might be a permanent road to access private inholdings.) This can also include trails.

Roadless Area - Areas identified during the Roadless Area Review and Evaluation process (RARE II) which have no roads and are at least 5,000 acres in size.

Roadsheds - Large blocks of land separated by major highways (in this case they are all state highways).

Road Management Objective (RMO) - Defines purpose, use, operational and maintenance level of road based on resource management and access and travel management objectives.

Road Upgrading - Includes erosion controls, road surface treatment to prevent dust and erosion, installing larger culverts and stabilizing fill slopes.

Short Term - In context of these guidelines, less than 10 years.

Stabilization - A process to slope, dip and waterbar travelways thereby reducing run-off concentrations and alleviating the risk of erosion and landslides if designed drainage structures

fail to carry storm runoff. This also includes grass seeding slopes. Unstable fill embankments that exceed the required travelway may be partially or fully removed.

Stormproofing - *See "Stabilization."*

Threatened Species - A plant or animal identified and defined in accordance with the 1973 Endangered Species Act and published in the Federal Register.

Travelway - A way for passage of vehicles, conveyances, persons, or domestic livestock (stock driveways & horse trails), developed by construction or use.

Transportation System - Roads, trails, waterways, and airways used to access forest.

TSPIRS - An accounting process developed jointly by the General Accounting Office and the Forest Service at the direction of Congress. The TSPIRS accounting system and the resulting report are intended to provide the Forest Service, Congress, and the public with an accurate statement of the cost and benefits of managing the national forest timber.

Viewshed - The landscape that can be directly seen from a viewpoint along a transportation corridor.

Watershed - The drainage basin contributing water, organic matter, dissolved nutrients and sediments to a stream, lake or river.

Watershed Analysis (WA) - Identifies key processes, functions and conditions within a watershed and describes past and current conditions and trends. This is an analytical process, which creates a tool to help identify and prioritize actions that implement Forest plans. Watershed analysis is ecosystem analysis at the watershed scale.

Water Barring - Berm or ditch-and-berm combination cutting across roads (and trails) at an angle such that all surface water running on the road and in the road ditch is intercepted and deposited over the outside edge of the road. These normally allow high clearance vehicles to pass.

Watershed Restoration - Improving current conditions of watersheds to restore degraded fish habitat and provide long-term protection for aquatic and riparian resources.

17.

18. REFERENCES

Forman, R.T., and A.M. Hersperger. 1996. "Road ecology and road density in different landscapes, with international planning and mitigation solutions". Pages 1-23 in Proceedings of the Florida Department of Transportation/Federal Highway Administration Transportation-Related Wildlife Mortality Seminar, G. Evink, D. Ziegle and J. Berry, eds. Orlando, Florida, April 30-May 2, 1996.

Murcia, C. 1995. "Edge effects in fragmented forests: implications for conservation". Trends in Ecology and Evolution 10:58-62.

Rakestraw, Lawrence and Mary. 1991. *History of the Willamette National Forest*

Reudiger, B. 1996. "The relationship between rare carnivores and highways". Pages 24-38 in Proceedings of the Florida Department of Transportation/Federal Highway Administration Transportation-Related Wildlife Mortality Seminar, G. Evink, D. Ziegle and J. Berry, eds. Orlando, Florida, April 30-May 2, 1996.

Soule, M. 1987. "Viable populations for conservation". Cambridge University Press, Cambridge, England.

USDA Forest Service, Forest Service Handbook 7709. 1988. Transportation Handbook, Process for Access Management, 7709.55.

USDA Forest Service. 1990a. Emergency Relief for Federally Owned Roads, Disaster Assistance Manual, Publication No. FHWA-FL-90-008.

USDA Forest Service. 1990b. *Land and Resource Management Plan, Willamette National Forest.*

USDA Forest Service. 1990c *The History of Engineering in the Forest Service, A Compilation of History and Memoirs, 1905-1989* Publication No. EM 7100-13.

USDA Forest Service, Forest Service Manual 2600 R-6 Suppl 2600-90-2. 1990 (Wildlife, Fish, and Sensitive Plant Habitat Management Policy 2610.3.2. WO Amendment 2600-90-2.2) "Recognizes State fish and wildlife...with management responsibilities for wild on National Forests and includes them as partners in planning and implementation of activities that effect wildlife and fish."

USDA Forest Service, Forest Service Handbook 7709. 1991a. Transportation Systems Operations Handbook, Travel Management. 7709.59-91-1.

USDA Forest Service, Region 6 Forest Service Manual, 7700. 1991b. Road restrictions information requirements and traffic management. R-6 Suppl 7700-91-1.

USDA Forest Service, Forest Service Handbook 7709. 1992. Transportation System Maintenance Handbook, Maintenance Level Descriptions, Maintenance Activities and Maintenance Standards, and Maintenance Sharing. WO Amendment 7709.58-92-1.

USDA Forest Service, Forest Service Handbook 7100. 1993. Forest Visitor Maps content required. R-6 Suppl 7109.13a.

USDA Forest Service, Forest Service Manual 7700. 1994a. Transportation System. WO Amendment 7700-92-6.

USDA Forest Service, Forest Service Manual, 7700. R-6 ID 1994b. Access and Travel Management, maintenance and funding. R-6 Suppl 7730-94-6.

USDA Forest Service, Siuslaw National Forest. 1994c. *Siuslaw National Forest Access and Travel Management Guide* Corvallis, Oregon.

USDA Forest Service, Willamette National Forest. 1995. *Willamette National Forest Access and Travel Management Guide* Eugene, Oregon.

USDA Forest Service, Washington Office. 1998. Road Analysis: A Procedure for Informi Management Decisions on the Future Characteristics of the National Forest Transportation System.

USDA Forest Service and USDI Bureau of Land Management. 1993. *Forest Ecosystem Management: An Ecological, Economic, and Social Assessment - Report of the Forest Ecosystem Management Assessment Team* (FEMAT). Portland, Oregon.

USDA Forest Service and USDI Bureau of Land Management. 1994a. *Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl* Portland, Oregon

USDA Forest Service and USDI Bureau of Land Management. 1994b. *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. Standards and Guidelines for Management of Habitat for Late-successional and Old-growth Forest Related Species Within the Range of the Northern Spotted Owl* Portland, Oregon.

USDA Forest Service and USDI Bureau of Land Management. 1994c. *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl*, Appendix J. Portland, Oregon.

US Department of Agriculture and US Department of Interior, 1994b. *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl*, Appendix J. Portland, Oregon.

US Department of Agriculture and US Department of Interior. 1997. *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath an Great Basin, Volume III. PNW-GTR-405. Pacific Northwest Research Station* Portland, Oregon.

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20. Appendices – Process Papers

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